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Nicaragua or Panama

The Substance of a Series of Conferences made

before the Commercial Club of Cincinnati
before the Engineers' Club of Cincinnati
before the Commercial Club of Boston
under the Auspices of the National Business
League in Chicago
before the Princeton University in New Jersey
etc., etc.

and of a formal address to the

CHAMBER OF COMMERCE OF THE STATE OF NEW YORK

By

Philippe Bunau-Varilla

Former Engineer-in-Chief of the Panama Canal; Director of the Congo Railway
President of the Madrid, Caceres, Portugal, and West
of Spain Railways

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* * *

The Knickerbocker Press
New York
1901

I firmly believe that when the Truth is advancing nothing can stop it ; I firmly believe that its irresistible pressure will overthrow any dam of prejudice erected in order to hold it back.

At the same time I think that individual efforts may largely help the Truth in its progress, by clearing from its path the obstructions of ignorance.

This was my aim when I answered affirmatively to three American friends who invited me to come to this country of free discussion in order to say publicly what they had heard in private conversation with me in Paris.

I am not here as the representative of any private interest ; I came to defend a grand and noble conception which gave me several happy years of struggle and danger, and for which I suffered many years of anxiety, during which I do not remember one hour of despair.

It has been to me a great privilege to have the opportunity of exposing to the clear light of day all the irrefutable facts which show that Providence has subjected to a severe test the sagacity of man, by giving apparently to the Isthmus of Nicaragua all good qualities, and to the Isthmus of Panama all defects for an interoceanic waterway, when in reality it has given to the latter and refused to the former all the attributes necessary for the establishment of this natural highway of nations.

I have been happy to speak in this great country, where the first official word of justice for Panama has come from the eminent Isthmian Canal Commission.

My purpose has been attained. I have worked for the scientific Truth on one of those fields, where, as Mr. Carnegie recently and justly said, there is no room for selfish and private aims.

PHILIPPE BUNAU-VARILLA.

NEW YORK, March 15, 1901.

GENTLEMEN:—It will be my effort to lay before you a series of facts officially or scientifically established and to show at their clear light the real aspect of this question of paramount importance.

Those facts, drawn from absolutely reliable sources, will help to pierce the dense mist of prejudice and erroneous impressions that floats over public opinion, which was misled both by the deceitful appearance of the natural conditions of the two canal routes of Nicaragua and Panama, and at the same time by the false idea that the Panama enterprise was paralyzed by technical impossibilities, when, on the contrary, the financial difficulties were the only cause of such paralysis, and came when, after a long struggle, all technical problems had been entirely solved.

It would have been a short time ago impossible to make the same demonstrations with the same authoritative statements because, though the facts that I could have brought had been the same, I would have been obliged to place them under the authority of the books that I published nine years ago, and I would have hesitated to ask from you so much credit for them.

To-day the situation is changed; an official commission formed of the most prominent engineers of this great country, so rich in eminent engineers, has thoroughly studied the question, and though they have presented but a preliminary report, which did not embrace all the points of this complicated question, nevertheless the facts already definitively settled by this high court of technical skill are so numerous and so precisely stated that a stable and permanent basis is at last offered for a clear, open, and loyal examination of the question.

In order to avoid any confusion about the authority of the statements that I am going to make before you I shall divide my speech into two distinct parts, which correspond to two natural divisions, from the point of view of the subject examined and from that of the authorities which cover the statements.

I am going first to submit to comparative examination all the points that characterize the routes of the Nicaragua and Panama from the point of view of construction or operation.

For the first part I shall not give any figures that are not extracted from the two American official reports on the subject, namely: The preliminary report of the Isthmian Canal Commission of November 30, 1900, and the report of the Nicaragua Canal Commission, 1897–1899.

Only some figures referring to the curves of the Panama Canal, and which are not to be found in said reports, will be extracted from the report of the Comité Technique of the Compagnie Nouvelle de Panama, made under the authority of first-rank engineers of America, England, Germany, and France; also some figures about the Chagres floods will be extracted from public documents of said Compagnie.

In the second part the facts that I shall state in relation to the stability of the construction are not given under the authority of the Isthmian Canal

Commission, who did not speak of that part of the subject in the preliminary report, and some facts only will be extracted from the report of the Nicaragua Canal Commission.

Before going into the discussion let us first have a look at the external appearance of the two routes.

APPARENT RELATIVE VALUE OF NICARAGUA AND OF PANAMA ROUTES.

The Nicaragua Lake is separated from the Pacific by a narrow Isthmus of 17 miles in width whose divide is very low (44 feet above the lake), while the Panama Isthmus is 45 miles wide, and its continental divide 330 feet above the sea. This exterior aspect is, I think, responsible for the false ideas formed in public opinion about the easiness of the Nicaragua Canal construction, because one is led to forget that the real and immense difficulties are not on the western side of the lake, but on the eastern side, in the valley of the San Juan (120 miles long), which a superficial examination leads one to consider as a natural waterway between the lake and the Atlantic, which it is far from being in reality.

Owing to that erroneous impression people generally believe that only a very short canal navigation will be met on the Nicaragua Isthmus, and that during nearly all the time of transit from ocean to ocean, ships will float in free deep water.

PART I

RESPECTIVE LENGTHS OF CANAL NAVIGATION.—There is an evident impossibility of utilizing the lower half of the San Juan for canal navigation, on account of the immense amount of sand brought into it by torrential and powerful tributaries coming from the volcanoes of Costa Rica.

Mr. Menocal, though abandoning the lower San Juan, hoped to replace that part of the river by two artificial lakes, formed by damming two northern tributaries of the lower San Juan, the San Francisco and the Deseado.

He further projected, in the Isthmus of Rivas, a third artificial lake between the Nicaragua Lake and the Pacific.

Those three lakes, as well as the San Juan River, between the Lake Nicaragua and the Ochoa dam, had to be kept at the same level as the lake itself. This route seemed to transform into reality the advantage which the Nicaragua route appears to have, namely, a short canal navigation, combined with the long free navigation in deep water.

This is how it was often asserted that under that plan, if not exactly 17 miles canal navigation, at least not more than 28 miles had to be expected between the oceans.

I showed in 1892 that this figure was much too low, and that 85 miles of canal navigation had to be met, if one takes into account all parts of the way, where ships have to navigate in a channel dug either in open land, or below the bed of a river, or below the bottom of a lake.

I pointed out also to what extraordinary difficulties such an extraordinary amount of damming would lead, and the danger of receiving above the Ochoa dam such tributaries as the San Carlos, with its enormous amount of sand.

The Isthmian Canal Commission, and before them the Nicaragua Canal Commission, rejected the Menocal plan as impossible, and thought that the first place admissible for the location of a dam was above the mouth of the San Carlos.

According to figures given by the Isthmian Canal Commission, the total length of canal navigation, under the plans they adopted, will be 120.53 miles, to which are to be added 66 miles that will be made in free deep water, either in river or in lake, making a total of 186.53 miles from ocean to ocean.

Of that total length of 120.53 miles of canal navigation, 22.19 miles will belong to an artificial channel dug below the bottom of Nicaragua Lake, and 27.96 miles to an artificial channel dug through sand and silt below the bed of the upper San Juan River, of which the larger part will be more than 16 feet below the natural level of the bed of that great river, which carries in flood 100,000 cubic feet of water per second, half given by the lake itself and the other half by lateral tributaries. Outside of the channels opened below the water, 67.33 miles will be dug through open ground, the harbor approaches forming the balance of the total length.

The 66 miles of deep-water navigation are formed by 48.74 miles in Lake Nicaragua, and 17.26 miles in the San Juan, immediately above the dam.

Let us now examine the situation in the Panama Isthmus as it will result by the project adopted by the Isthmian Canal Commission.

In Panama we find but 38 miles of canal navigation, to which must be added 7 miles deep-water navigation through the artificial lake formed above Bohio, by the dam projected there across the Chagres at a distance of 15 miles from the Atlantic Ocean.

In fact, the canal navigation in Panama will be less than one third that of the Nicaragua route. I need not say how much reality differs from the external and apparent aspects of the two routes in regard to lengths of canal navigation.

DEPTHS OF GREAT CUTS.—The continental divide is in Panama, 330 feet above the level of the oceans, and 274 feet above the bottom of the cut projected by the Isthmian Canal Commission; those measurements applying to the natural and original state of the ground. This is the so-called Culebra cut.

The work executed by the old and the new Panama Company leaves to-day 110 feet excavation to be made above said bottom. It is the deepest cut that remains to be excavated on the line of the Panama Canal. One sees to what to-day is reduced this terrible difficulty of the Culebra, which was really the greatest that the construction of the Panama Canal has met, and which during the first six years of the construction remained as an unsolvable problem.

I have related, in 1892, by what method I had been able to meet that immense difficulty and to take it out of the way of the construction of the Panama Canal. It is to that task that I mostly consecrated the last two years of my presence on the Isthmus of Panama.

Let us now see what aspect the question of deep cuts on the Nicaragua Isthmus presents.

On the Nicaragua route, we find that the continental divide is not the place where the deepest cut is necessary.

As already stated, the cut at the continental divide is insignificant (44 feet above the lake), but a high cut of 297 feet above bottom and others of 218 and

170 are to be met in the low valley of the San Juan to go through high ridges projecting in said valley.

These facts show that most unexpectedly the Nicaragua location is, from the point of view of depth of cuts, by far the worse of the two routes, and that the ratio of 1 to 3 in favor of Panama is to be found equally for length of canal navigation and depth of cuts.

DAMS.—I will not weary you about details of technical descriptions as to the relative importance of the two dams to be built, either in Nicaragua or in Panama. Let me only say that the Isthmian Canal Commission stated that the dam to be built in Panama can be built of earth as well as of masonry, which indicates that neither its difficulty nor its cost is extraordinary, and that the same Commission, speaking of the Boca San Carlos dam, on the Nicaragua route, said that "the most difficult engineering work in connection with the Nicaragua Canal project is the construction of a dam across the San Juan River to hold back the waters of the lake, and enable its level to be regulated."

This dam would necessitate compressed air foundations to a depth of 100 feet below low-water level of the river, and have a total height of 150 feet from the crest to the foundation.

The Commission estimates that eight years would be necessary for its construction.

CHAGRES REGULATION.—Let me add that the dam to be constructed at Bohio (Panama) does away entirely with this monster of imagination called the Chagres. What has been said of the Chagres, and the difficulty its regulation presents, has been immensely exaggerated. The Commission has proposed to build a dam in order to form a lake whose normal level would be at 85 feet above the sea. The outlet of that lake will be 2000 feet wide, and the surface of the lake combined with the dimensions of the outlet are such that the largest floods ever known will be incapable of raising the surface of the lake more than a little over 5 feet. I do not wish to enter into tiresome technical details, but I trust you will accept the statement about the easy regulation of the Chagres, because it is a conclusion arrived at by the eminent American Commission itself.

We have seen when speaking of deep cuts to what the Culebra difficulty, which was a great and real one, is to-day reduced; we have also seen to what the Chagres difficulty, which was never a real one, has been reduced.

Culebra and Chagres are the two names that symbolize in public sentiment the impossibilities of a passage through the Panama Isthmus. Both of them must be totally erased and disappear from the public mind.

LOCKS.—In reference to the locks which will be constructed, it will be sufficient for me to state that nine locks will be necessary in Nicaragua and only five in Panama, and that the level to which the ships will have to be lifted will be, in the case of the Nicaragua route, 110 feet at maximum, and, under equal conditions at Panama, 90 feet.

The foundation of all locks in Panama will be on rock, and only five in Nicaragua will enjoy such advantages; the other four, says the Commission, "are located on foundations that are believed to be safe."

NICARAGUA GALES.—The winds in the Nicaragua Canal location are exceptionally violent and permanent.

This is the result of the geographical situation of the San Juan valley, open to the trade winds and parallel to their general direction. The lateral high mountains of Nicaragua and Costa Rica form a barrier to the continuous trade winds, which is only open through the San Juan depression. Those continuous and violent gales, much heavier than trade winds at sea, will be a great obstacle, and a great danger for navigators. In Panama nothing of the sort is to be feared, as the Canal is in a direction from northwest to southeast, perpendicular to the trade winds. Lateral mountains shelter absolutely the Canal from any access of trade winds.

CURRENTS.—Concerning river currents, it will be easily understood that, the San Juan River having a much larger watershed than the Chagres, and the Nicaragua Isthmus being much more rainy (from 2 to 2½ times more than the Isthmus of Panama), the quantity of water, though its flow is regulated by the Nicaragua Lake, will be much greater, and generate much more permanent and intense currents than will be the case in Panama, where the great floods of the river are of very short duration, and do not occur at more frequent intervals than three years or more.

To illustrate this state of things, the appendices to the Nicaragua Canal Commission's report and the official documents of the Panama Canal Company give most interesting figures. From measurements taken during ten consecutive years (1889 to 1898), at Gamboa, at the beginning of the five miles where the Chagres and the Canal will be in the same location, the average discharge of the Chagres has been 3400 cubic feet a second, and the average discharge during the last six months of every year has been 4800 cubic feet a second.

Measurements taken in 1898 in the San Juan River show that the average mean discharge above the mouth of the San Carlos has been 25,000 cubic feet a second for the whole year, and 31,400 for the last six months.

This shows the relative importance of the two rivers. And at the same time it must be borne in mind that the rainfall at the Atlantic terminus of the Nicaragua Canal at Greytown in 1898 was only 201.64 inches, while the other figures given in the Nicaragua Commission's report are 296.64 inches for 1890,—214.27 inches for 1891,—291.20 inches for 1892, these being the only years when the rainfall was reported for Greytown. It shows that the figures above given for river discharges in Nicaragua are more like a minimum than anything else and that probably half more may be often expected.

In the same comparatively dry year of 1898, the average of the maximum discharge of the San Juan measured in every one of the last six months of the year was 45,500 cubic feet a second, the highest maximum discharge for that period being 70,500 cubic feet a second, in November. (Measurements above mouth of San Carlos.)

In the Chagres in the last twenty-one years five great exceptional floods have taken place, which lasted only a few hours and gave at Gamboa a discharge of 72,000 cubic feet a second in 1879,—58,000 cubic feet a second in 1885,—58,000 cubic feet a second in 1888,—58,000 cubic feet a second in 1890, and 42,000 in 1893.

It is obvious that the great floods of the Chagres, which may be considered as an exceptional incident, lasting for two or three days, and occurring at very rare intervals, give about the same amount of water if not less as the average monthly winter great flows in the San Juan above the mouth of the San Carlos River.

MAINTENANCE OF THE CANAL CHANNEL IN THE BED OF THE SAN JUAN RIVER.—What will be the effect of each flow on the maintenance of the canal channel dug into the bed of the San Juan is extremely difficult to calculate.

There is not a part of the technical science where man feels more the weakness of human knowledge than in such a question.

The form of the bed of a big river is the resultant of the very complicated mechanism of different factors associated together, namely, the amount of water discharged, the variation to which the discharge is submitted, the quantity of gravel, sand, or silt carried by the floods, the relative densities of those materials, the obstacles met by the river, the declivity of the country on which it flows, etc.

It is impossible to calculate the part every one of those factors has in the definitive determination of the form of the bed, but it may be stated that when the industry of man makes it necessary to change with brutality the natural form of the bed, and to transform it into a new channel, this channel, if in harmony with our needs, is in absolute contradiction with the natural needs of the river, and one may expect to sustain with nature one of the most dangerous struggles, one of those where man has been often totally defeated.

A striking example of the variety of forms that a river bed can take is precisely offered by the San Juan above and below its junction with the San Carlos.

From the Machuca Rapids to the mouth of the San Carlos, a distance of about fifteen miles, the San Juan has a very deep bed, 40 and even 44 feet in some places at low water, and very little fall, about one foot for the whole distance.

Below the mouth of the San Juan to Ochoa the bed is about 12 feet deep at low water, and the fall 6 feet for 3 miles.

The river is in that latter part twice wider (in rough figures) than above the San Carlos mouth.

Of course the inclination of the water surface, associated with its reduced depth, generates a sensible current, even in very low water, below the mouth of the San Carlos, while, on the contrary, the water runs very sluggishly in the deep bed above.

On account of this sluggishness in that part of the river, it was termed "Agua muerta" (Dead water).

The first impression given by the existence of such a deep channel where water is very slow conveys the idea that the river has been unable to fill up the bed with sand or silt as it did below the mouth of the San Carlos, and that therefore the waters of the San Juan River are exceptionally clear. But a closer examination dismisses this impression.

It would be necessary to imagine that the San Juan waters above the San Carlos are as pure as distilled water, to think that in the course of centuries their sediments could not fill the bottom of that channel.

The cause must evidently be referred not to the scarcity of sediments but to the impossibility for the stream to gain room in width on account of lateral obstacles. Probably no other way was left to the river, to convey the mass of water that has to pass periodically in floods, but to dig into its proper bed a deep channel for itself.

As soon as the flood is over and the temporary fall created by the very flood has disappeared, the river takes a sleepy aspect which does not throw any light on the quantity of sediment that has passed during the flood, and that will stay in the bed if the natural conditions are altered by the intervention of man, if, namely, the section through which water has to flow is brought from 6000 or 7000 square feet to 40,000 or 50,000, as will be the consequence of the construction of a dam raising the natural level of water about 50 feet.

Returning to the most important question of sediments, and after having shown that the "Agua muerta" does not prove anything about their scarcity or their abundance during the floods, let us see what tributaries fall into the San Juan above the "Agua muerta."

We see about thirty miles above the San Carlos mouth a great tributary called the Poco Sol.

This tributary is set forth in the Nicaragua Canal Commission's report as follows: "The principal tributaries from the Costa Rican side are the Rio Frio, *Poco Sol*, San Carlos, and Sarapiqui. *These large streams* exert a controlling influence in confining the location of the canal to the left bank."

In the geological report we find this river alluded to as follows: "The San Juan River receives only small tributaries from the north, while it receives both small and large from the south. The large tributaries include the Frio, *Poco Sol*, San Carlos, and Sarapiqui. *These all head upon the slopes of the Costa Rican volcanic range* which forms the southern margin of the Nicaraguan depression."

To judge the influence of the entrance of such a stream in the middle of the section of the San Juan which will be consecrated to canal navigation, it would be very desirable to have exact measurements of the volume of its discharge and of the quantity of sediments brought.

Unfortunately no measurements of that large stream were reported by the Nicaragua Canal Commission, as has been done for the three other great and torrential tributaries, falling from the slopes of the volcanic range of Costa Rica, namely, the Frio at the west of the Poco Sol and the San Carlos and Sarapiqui at its east, all three bringing enormous masses of water in floods and enormous masses of sediment.

In the absence of precise data some very probable notion may be formed of the relative importance of the Poco Sol.

The San Carlos has a drainage area of 1450 square miles. The Sarapiqui has a drainage area of 1100 square miles. The drainage area of the Poco Sol has not been given, but the drainage area of the tributaries of the San Juan from the Savalos River to a point near and above the San Carlos is 750 square miles. The only important tributary in that section of the river is the Poco Sol, and its watershed may be estimated with that of the Poco Solito as at least between half and two thirds of the total surface.

One may say for the sake of comparison that the drainage area of the Poco Sol is between one quarter and one third of that of the San Carlos, that it comes from the very same volcanic region as the San Carlos and flows on the very same ground. The natural consequence ought to be that it brings a proportional quantity of water and sediment. We have a statement which confirms that view in what regards water discharge.

The total discharge of the tributaries into the San Juan between Savalos River and San Carlos River was calculated to have been in 1898 about 4,500,000 acre feet, to which, according to the above estimate, between 2,290,000 and 3,000,000 ought to have come from the Poco Sol River. The similar figure calculated for the San Carlos proper is 7,661,000, of which the third part would be about 2,500,000, an amount which approximately confirms the above estimate.

We fail to see any material fact that could lead one to think that a similar proportion should not be the very same one between the quantities of sediment brought into the San Juan River by the Poco Sol and by the San Carlos.

Only the fact that the river bed is, for a distance of fifteen miles above the San Carlos, deep and that the San Juan River there is sleeping at low water could lead to a different conception, but we have shown that it does not prove anything about the amount of sediment of the upper river, and results simply from the different factors that determine the form of the bed and which do not allow any sediments to stay there, but force them farther down the stream.

If such a proportion as three or four to one was proved to be the real one between the amount of sediment brought by the San Carlos River and that brought by the Poco Sol River into the San Juan River, or even a much lower one, as the amount of sediment brought by the San Carlos River was considered as equivalent to a formal impossibility of maintaining any channel in the San Juan below the San Carlos, the maintenance of the depth and width of the canal channel in the same river between the Poco Sol and the San Carlos, which was estimated by the Isthmian Canal Commission as being within the limits of practicability, could not fail to be an extremely difficult one.

Most likely the exact determination of the watershed of the Poco Sol, from precise surveys in the volcanic region from whence it comes, as well as its mean and flood discharge, and the appreciation of the amount of its sediment in flood, as much as can be done by experimental tests, will be found in the definitive report of the Isthmian Canal Commission, and will settle this very important point.

We shall finish the study of this chapter by saying that even leaving aside the amount of sediment carried by the river or thrown into it by its tributaries, the maintenance of a channel of the required width and depth is by itself a very difficult problem in such a powerful stream as the San Juan.

Nature does not like a regular depth and width in the bed of a great river ; it is contrary to its laws. In curves the river fills up the concave side of its bed and digs the convex side, and when it changes its curvature from one side to the other, the river expands and fills up its channel to get an intermediary state for passing from the deep channel on one side to the deep channel on the other side.

This any great river will do constantly with the proper elements of its bed without borrowing any foreign material, and the problem, even without any intervention of sediments from lateral tributaries, is a difficult one to solve. The difficulty can, of course, easily go over the boundaries of human practicability when the question becomes complicated with that of great masses of sediment brought into the bed.

CURVES.—To examine this very important subject of curvature, the most essential of all for safe navigation, we have not yet the definitive plan of the Isthmian Canal Commission, for the Nicaragua Canal, but as this Commission has adopted in its essential lines the Nicaragua Canal Commission's project, and as curvature is commanded nearly absolutely by the natural disposition of the ground, one may take, as a fair approximation, the curvature of the Nicaragua Canal Commission's route as the one that will be more or less presented by the definitive project. Leaving aside the curves in harbors, or at the entrance of the locks, where the ships have a very reduced velocity, we find that the Panama route has 23 curves of a totalized length of 19.5 miles, and that the Nicaragua route has 82 curves of a totalized length of 53.5 miles.

It is not enough to state the number of curves; it is much more important to state their radii. All the curves of the Panama canal are of 10,000 feet radius or more, with the exception of three, which have 8200 feet radius. There are, on the contrary, 69 curves in the Nicaragua Canal below 8000 feet, of which 50 are between 3000 and 4000 feet radius.

But it is not only the number of curves and their radii which has to be considered, but also whether they are located in places where water will be still or not.

In Panama there are only three curves of 10,000 feet radius where the Canal and the Chagres will be in the same location, that is to say, where eventually currents may take place. In Nicaragua we find 58 curves, having a total extension of 37 miles, where the Canal will be located in the San Juan River itself, and of those 58 curves, 43 are between 3000 and 4000 feet radius, and have a total extension of 26 miles.

It must be borne in mind, that in that part of the Canal there will be nearly 28 miles excavated into the bottom of the river to a depth of 16 feet for the larger part. The maintenance of that channel opened into silt and sand seems (from my personal point of view) to be extremely difficult, and will necessitate constant dredging in a river carrying in floods 100,000 cubic feet of water, that is to say, one quarter of the amount in the Niagara Falls.

It is obvious that ships will meet there an accumulation of extreme difficulties, sharp curves, heavy river currents, constant heavy gales and impediments either from the dredges themselves, or from the sand and silt they will have to remove.

Who could guarantee that those combined difficulties when brought to the extremes simultaneously would not stop sometimes, even if not often, all transit?

In Panama, the large and easy curves, the absence of winds, the scarcity of river currents, and the rarity of floods, give quite a reverse impression as to the eventual facilities offered to ships.

HARBORS.—With regard to harbors, the advantage, as every one admits, is with Panama, both of whose terminals have excellent harbors. The Nicaragua Atlantic terminal is very bad. The immense quantity of sand thrown into the sea by the San Juan, whose mouth lies south of Greytown, is maintained in suspension by the continuous agitation due to the constant easterly trade winds, and brought into Greytown by a continuous northern stream of sand. The Greytown harbor, which, fifty years ago, was a good one, is now virtually closed by the constant accretion of the sand, and the maintenance of the entrance to the Canal there would be very difficult.

If it is understood by the designation of harbors, those points of the route where canal navigation is changed for a navigation into an immense body of water beaten by storms, and liable to give great waves, one is entitled to say that the Nicaragua route, outside of its ocean harbors, has two others in the Lake of Nicaragua.

This lake is a real sea, about as large as the sea of Marmara.

The violent gales that continually blow over it, with sudden changes of direction due to the reflection of the currents of air on the mountains, make this interior sea always agitated. Its violent storms are quite characteristic and well known.

An inferior current brings to the southeastern side all the light sediment thrown into the lake by its tributaries, and this sediment accumulates in the region where the outlet of the lake, the San Juan, is located.

An artificial channel twenty-two miles long has to be dug in that mass of mud, and this channel forms, so to say, the harbor approach on the east side of the interior sea. Close to the point where this channel leaves the shore, a great torrential tributary of the lake, carrying a considerable mass of sediment, brought from the volcanic ridge of Costa Rica, falls into the lake: it is the Rio Frio, which will not add to the facility of maintaining the channel depth.

To judge at the same time the extraordinary difficulty of that maintenance and the danger to which transitting ships will be exposed in that harbor approach, one must forget the name of lake, which conveys the erroneous idea of still, sleeping water, and think what an unprecedented enterprise it would be to make an harbor approach in the ocean consisting of an artificial channel, twenty-two miles long, opened into mud or silt, and constantly exposed to be brutally filled up by the sweeping waves at every storm.

Such a point of view would be in the actual case much nearer to reality, than the conception of a channel opened into the bottom of a Swiss lake.

BUILDING EXPENSES AND TIME OF TRANSIT.—The exceptional advantages which characterize the Panama route compared to the Nicaragua route are in no way counterbalanced by larger building expenses. According to the estimates of the Isthmian Canal Commission, the completion of the Panama Canal will cost 58,000,000 dollars less than the construction of the Nicaragua route, which is estimated at 200,000,000 dollars. It is obvious that the estimation of the cost of completing such a work, where already 77,000,000 cubic yards have been excavated, in all parts of the Isthmus and in all conditions of work, enjoys a far higher degree of certainty than an estimate made on a line where no works have been executed *;

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* The Isthmian Canal Commission states that the only excavation executed on the Nicaragua Isthmus consists of a channel between 150 and 230 feet wide, 16 feet deep and three quarters of a mile long. This insignificant work made in the Greytown swamps represents a cube inferior to one three hundredth part of the total volume of the prism of the Nicaragua Canal.

on the other hand it is a matter of common experience that whatever be the care with which surveys, soundings, and plans are made, the unforeseen circumstances which are met in a new ground do not modify the previsions towards reduction of expenses but towards increase.

The time of transit is estimated by the Isthmian Canal Commission, at twelve hours for Panama and thirty-three for Nicaragua. If one remembers the length of the two routes, and the number of locks, it is evident that this calculation must have been based upon the hypothesis that ships will go at the same speed in both cases, and that no allowance was made for the difficulties to be met on the Nicaragua route.

This shows that the advantage of distance over Nicaragua, between both sides of North America, is practically erased by time of transit.

PART II

STABILITY.—I propose now to touch upon another point which does not concern the construction proper of the Canal, but has reference to future contingencies, and which was not discussed by the United States Isthmian Canal Commission in its preliminary report.

I wish to speak of a danger arising from seismic disturbances, both during construction and after.

In Panama, there is within a distance of one hundred and eighty miles from the Canal no volcano, even extinct. The Isthmus there, since its formation in the early quarternary period, before man appeared on the earth, has not been modified.

This is quite the contrary in Nicaragua, which has been always the site of seismic convulsions, whose lake was formerly a gulf of the Pacific Ocean, and whose name was associated with the most terrible volcanic explosion ever recorded in history before the Krakatoa explosion in Sound's Islands.

The explosion of the volcano Coseguina in 1835 lasted 44 hours, the noise was heard at a distance of 1000 miles, the ashes were brought 1400 sea miles by the winds, the mass ejected into the air was calculated to have covered a surface equivalent to eight times the surface of France, and the volume was calculated to be equal to 50 cubes having sides of 1100 yards, which allows me to say that during these 44 hours the volcano *ejected every six minutes a volume* of stone and ashes *equal to the total volume of the prism of the Nicaragua Canal*, as it was calculated by the Nicaragua Canal Commission, and which will necessitate eight years of excavation.

In the very centre of Lake Nicaragua is a volcano in constant activity, the Omotepe, whose last great eruption occurred in 1883.

Between the two above named volcanoes we find a series of volcanoes in recent or continuous activity, the Hell of Masaya, on the shore of Lake Nicaragua, the celebrated Momotombo, on the shore of Lake Managua, the volcano of the Pilas, which was born in 1850, the Santa Clara, the Zelica, the Nindiri, being the best known of them.

The continuity of volcanic disturbances is stated in an appendix to the Nicaragua Canal Commission's report: "In the northwestern part of Nicaragua slight earthquakes are frequent. *Scarcely a month passes without one or more being noticed.* The centre of these disturbances is always near the line of the Nicaragua volcanoes; *the line of volcanoes begins with*

Madeira (near the Omotepe), at the southern end, in Lake Nicaragua, and terminates at Coseguina, at the northern end, near the gulf of Fonseca."

Two most important facts have been recently established by Mr. BERTRAND, foremost geologist and member of the Institute of France.

(1) *The Lake Nicaragua is one of the three lines of least resistance in Central America, which are a site of election for great seismic disturbances.* It is the line of depression between the Costa Rican volcanoes and the Nicaraguan, and plays the same part as the other two: the bay of Fonseca, which is a volcanic lake characterizing the depression between the Nicaraguan and Salvadorian volcanoes, and the Lake Pacayan, characterizing the depression between the Salvadorian and Guatemalan volcanoes. These two last lines of least resistance have been the site of the most terrible convulsions owed to the Coseguina for the former, and to the Fuego (Fire) for the latter.

(2) *The underground fire is going south, and increasing in Nicaragua.* From the figures given by Mr. BERTRAND I calculated that before the nineteenth century, out of all the great explosions or earthquakes recorded, 45% belonged to Guatemala, 35% to Salvador, and 20% to Nicaragua, whereas in the nineteenth century, only 30% belonged to Guatemala, 45% to Salvador, and 25% to Nicaragua, showing an evident tendency to a displacement of the activity southward and an increase in Nicaragua.

To justify these figures one can say that several volcanoes became extinct in Guatemala, and that none was extinct in Salvador nor in Nicaragua, but, on the contrary, that two were born in Salvador, Izalco, in 1770, and Ilopango, in 1880, and one was born in Nicaragua, that of Las Pilas, in 1850.

DANGER FOR CONSTRUCTION.—The continual earthquakes may have a fatal influence on the definitive transformation from half-liquid mud into hard stone, of the concrete, which will during eight years be continually poured in the great Boca San Carlos dam; these violent shocks, interfering every month or more with the gradual crystallization of the elements of concrete, may destroy their reciprocal adherence, and ruin the perfect homogeneity of the solid mass which is imperatively necessary for the part it has to play.

DANGER FOR THE CANAL ONCE BUILT.—It is entirely false to compare the equilibrium of dams and locks with that of a high tower or of a church. A wall or tower even fissurated can stand after an earthquake. A longitudinal fissure in a dam, which will not alter its equilibrium as a wall without pressure of water, would mean its immediate overthrow when the water pressure is exerting its force upon the surface of the inside fissure.

Outside of the impending and terrible danger of seeing ruined the dam or the locks by a great seismic commotion, one must not forget that there is great probability of seeing formed in the sea of Nicaragua, which is 100 miles long and 45 miles wide, one of those terrible tidal waves which were so destructive in Lisbon (earthquake of 1752), and Krakatoa, 1883, the latter being 100 feet high and the former 40, and which caused unlimited disaster.

It must be borne in mind that these terrible menaces would mean, if realized, not only the destruction of that costly Canal, but the ruin of the immense interests of both sides of America, which will have been developed by the great waterway and receive a death blow by its paralyzation.

TRANSFORMATION OF THE PANAMA CANAL INTO A BOSPHORUS.—Nothing similar can be feared in Panama, as no trace of any local volcanic activity may be found on that Isthmus, whose rare and small seismic vibrations come from distant centres.

The future, on the contrary, far from being open for destruction, is open for a gradual transformation from a lock canal into a level canal, into a Bosphorus, which means a rapid transit in five hours from ocean to ocean. This can be done without stopping or troubling the navigation even for a quarter of an hour, by following the solution I have given years ago to this question, which is extremely simple, and consists, all engineers will understand me, in making the two gates of a lock of the same height.

CONCLUSION

The facts that I have related demonstrate the following statements:

I. It is very questionable whether the continuous earthquakes will allow the construction, on the Nicaragua route, with all its indispensable qualities, of a substantial masonry dam, which is the key of the whole Canal.

II. Admitting a dam could be built, the Nicaragua route, whatever may be the engineering skill displayed and the expenses made, will *never acquire* the two most essential qualities necessary to an interoceanic canal,—*continuity of operation* and *security of transit.*

The large ocean steamers will have there to struggle, deprived of any means of resistance,* against the combined efforts of the continuous violent gales, of the heavy river currents, of the impediments resulting, of the constant modifications of the depths in the channel, and of the presence of the numerous dredges that will have to keep the way open, and this when they will be steering with great difficulty around an extraordinary number of curves, the short radii of which ought to be, in themselves, considered as incompatible with the navigation of big ocean ships in a narrow channel.

The ships will also have to meet two bad, exposed, and dangerous passages, when going from the Atlantic into the Canal and from the Canal into the Lake of Nicaragua.

One is allowed to say that *continuity of transit* and *safety of navigation will be constantly at the mercy of conflicting elements and beyond the control and prevision of man.*

III. If the experience of four centuries is not a mere word, if the undisputable proofs, written in letters of fire on the surface of the soil,* of the continuous violent and increasing volcanic activity in Nicaragua, are not a mere dream, the route over that Isthmus is not only eventually exposed to, but certain, sooner or later, to be the prey of, that uncontrollable power of nature before which flight is the only resource.

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* It is a fact well known to naval men, that a big ship floating in shallow water is partially deprived of its steering faculty. The reaction of inferior currents on the rudder disables it to a certain extent, and its action is uncertain and irregular.

The accident suffered by the battleship *Massachusetts*, that got aground going out of Pensacola on the 21st March when this pamphlet was in course of printing, is a good illustration of this disability of steering in shallow water.

If one thinks that not only the enormous cost of such a waterway would be at stake but also the very basis of the prosperity, the wealth of the millions of people who will settle on the west coast of North America, as soon as the construction of the Canal will join them with the other side of the continent and with Europe, one hesitates to calculate the consequences that would result from one of those seismic convulsions, which most probably will be still more terrible in the future than they have been in the past on that part of the Isthmus.

To prefer definitively the Nicaragua route to the Panama route, the unstable route to the stable one, would mean to prefer the stability of a pyramid on its point to the stability of a pyramid on its base when to that stability is attached the prosperity and welfare of a whole continent.

IV. The Panama route, having no winds, no currents (except on rare occasions), no sharp curves, no sediments, no bad harbors, no volcanoes, enjoys to the highest degree the three essential qualities totally wanting for the Nicaragua solution,—*continuity of opera-*

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*To the people who think I am exaggerating this capital point I will say: Open any dictionary of geography, any encyclopedia, and read the article titled "Nicaragua." I will say also: look at the coat of arms of the Republic of Nicaragua, look at the Nicaraguan postage stamps. Young nations like to put on their coat of arms what best symbolizes their moral domain or characterizes their soil. What have the Nicaraguans chosen to characterize their country on their coat of arms, on their postage stamps? Volcanoes!

*tion, security of transit, stability of structure.** Outside of that it is three times shorter, will cost much less than the Nicaragua route and is easily transformable into a Bosphorus, the only form that will definitely answer to the world-wide interests to be served by the route, and allow of a passage from ocean to ocean in five hours.

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* The superior qualities of the Panama route, from the point of view of safe and continuous operation, are such that it can be fairly asserted that, assuming the two canals were built and that of Nicaragua freed of any tolls, ships would, in the intermittent periods of navigability of the Nicaragua Canal, still prefer the Panama route, as the tolls of this Canal would certainly be less than the insurance fees to be paid to pass over the unsafe route of Nicaragua.

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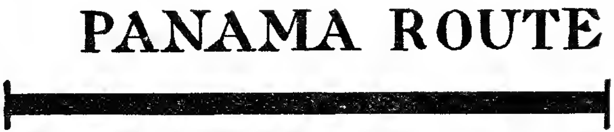
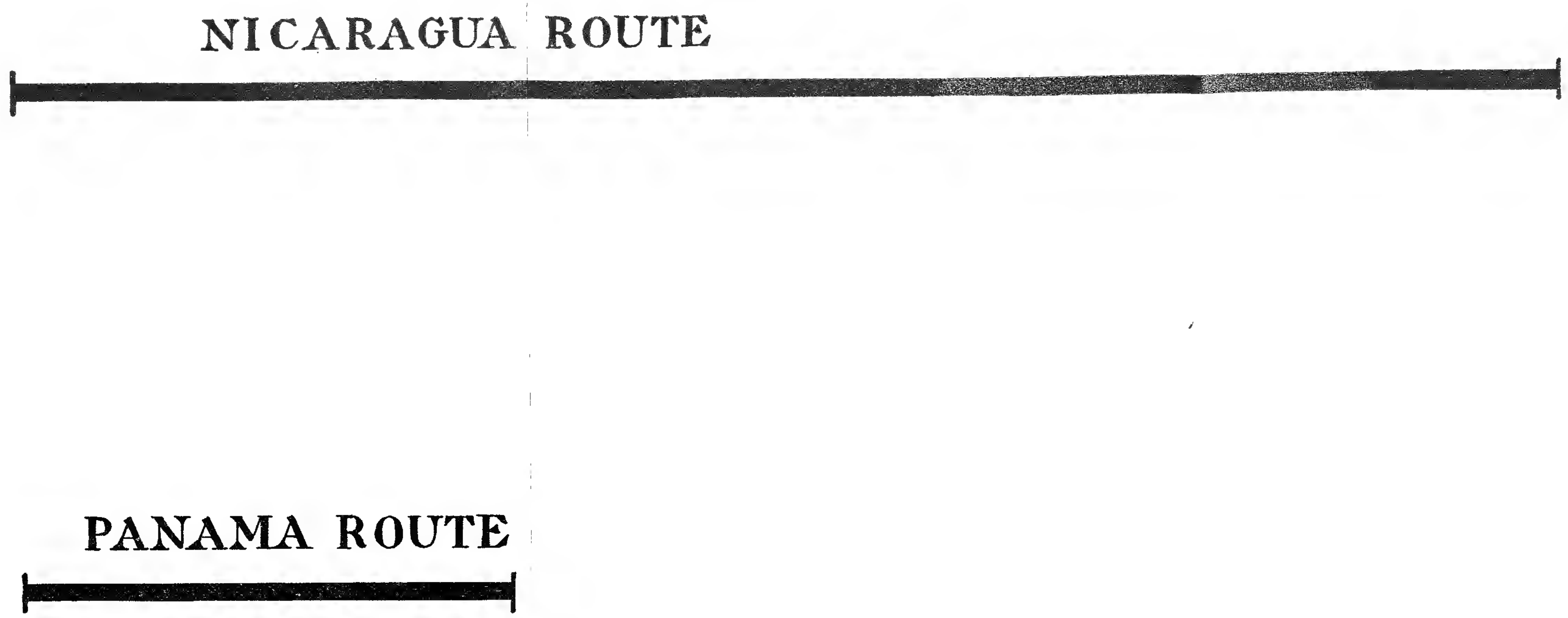


RESPECTIVE LENGTHS OF CANAL NAVIGATION OVER THE NICARAGUA AND PANAMA ROUTES.

THIS plate, drawn at the same scale of one inch per twelve miles, gives the relative lengths of canal navigation in both routes, according to the figures of the Isthmian Canal Commission's Report, being understood by canal navigation all the parts of the way where ships will have to follow an artificial channel, whether dug in open land or below the bed of a river or below the bottom of a lake, and without taking into account the part of the way where ships will float in free deep water. Canal navigation will be 120.53 miles in Nicaragua, and 38 miles in Panama, to which must be added 66 miles in Nicaragua, and seven miles in Panama, for deep-water navigation.



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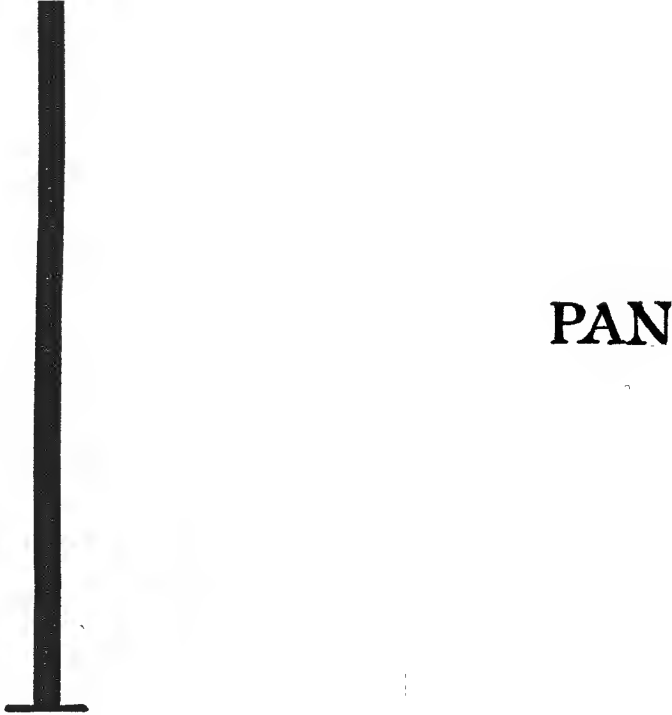

CURVES ON THE NICARAGUA ıNAMA CANAL ROUTES.

THIS plate gives the successive curves l be met
by transitting ships on the Nicaragua r on the
Panama route, drawn at the same scale, c r 12,000
feet, together with their respective radii distribu-
tion in the different sections of each cana ıside the
curves in harbors or at the entrances of re ships
have a very reduced speed.

The consideration of the curves of the Nicaragua route will show how numerous and sharp the curves are in the section of the Nicaragua route where the Canal will be located in the San Juan River proper, in whose bed an artificial channel has to be opened for a total length of 27.96 miles, through sand and silt to a depth of sixteen feet below the bed (for the larger part). It must be borne in mind that ships steering around these curves will at the same time have to meet not only the river currents but also the abnormally heavy, continuous winds of the San Juan Valley and the dredges that will have to keep open the artificial channel in that big river, whose floods are estimated at 100,000 cubic feet a second, and whose measured mean discharge was, from July to December, 1898 (a comparatively dry year),[†] 31,000 cubic feet a second, the average monthly maximum being 45,500 cubic feet a second, and the highest maximum 70,000 cubic feet a second.

The consideration of the curves on the Panama route will show how few they are, and that they have the large radii indispensable for an easy transit of large sea ships. It will be seen that only three curves each one of 10,000 feet radius will be met where the Canal and the Chagres are in the same location. Outside of the small number of large curves, ships will meet there with no winds and very little current, as the average discharge of the Chagres at Gamboa is only 4800 cubic feet a second from July to December; and the great exceptional floods (four in twenty-one years) having given 72,000 cubic feet a second in 1879, 58,000 in 1885, 58,000 in 1888, 58,000 in 1896, and 42,000 cubic feet a second in 1893, each one lasting two or three days, and the natural bed of the river being all along below the bottom of the Canal.

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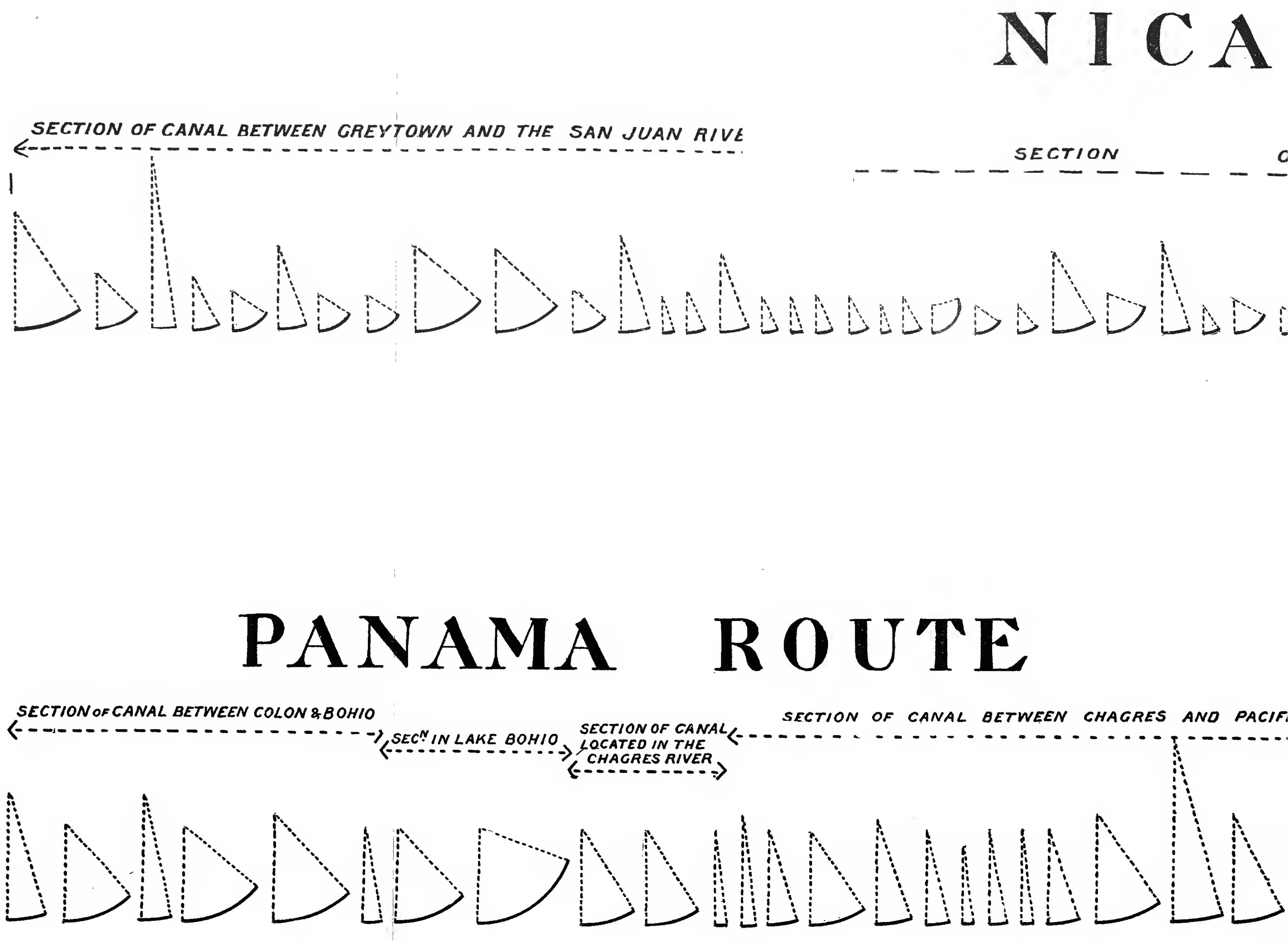
[*] The Isthmian Canal Commission not yet having published their definitive project, the Nicaragua curves are taken from the Nicaragua Commission's reports (profiles), whose route was adopted in its essential lines by the Isthmian Canal Commission.

[†] The report of the Nicaragua Canal Commission gives the following data for rainfall at Greytown, which only apply to four years: In 1890 the total rainfall was 296.94 inches; in 1891, 214.27 inches; in 1892, 291.20 inches; and in 1898, 201.64 inches, which shows that much greater flow of water may be normally expected than that measured in 1898.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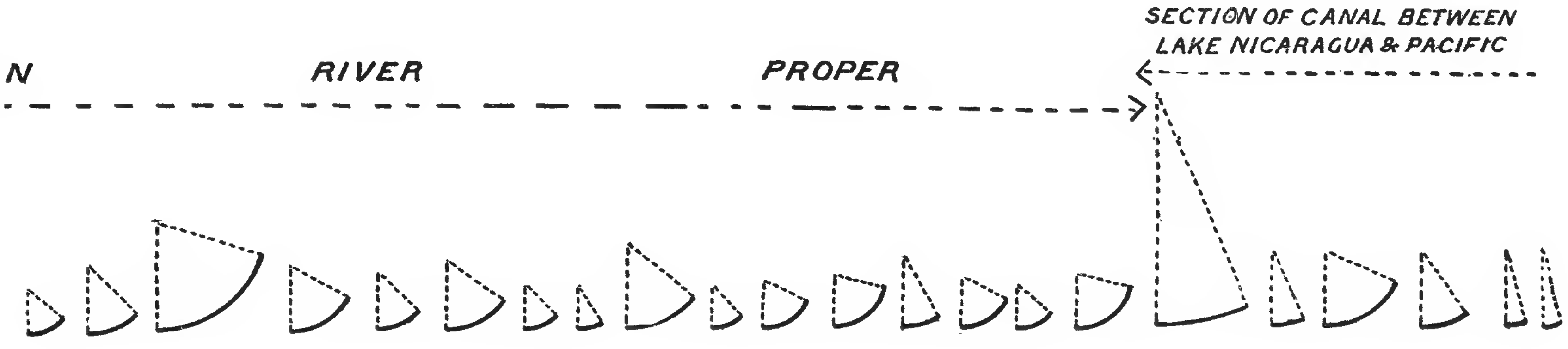
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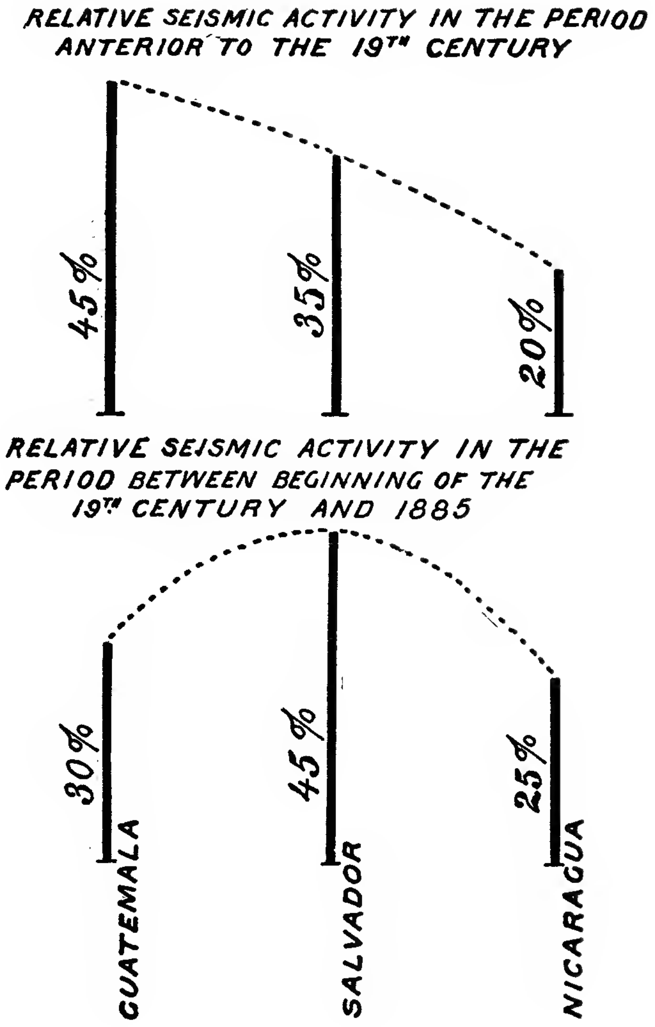
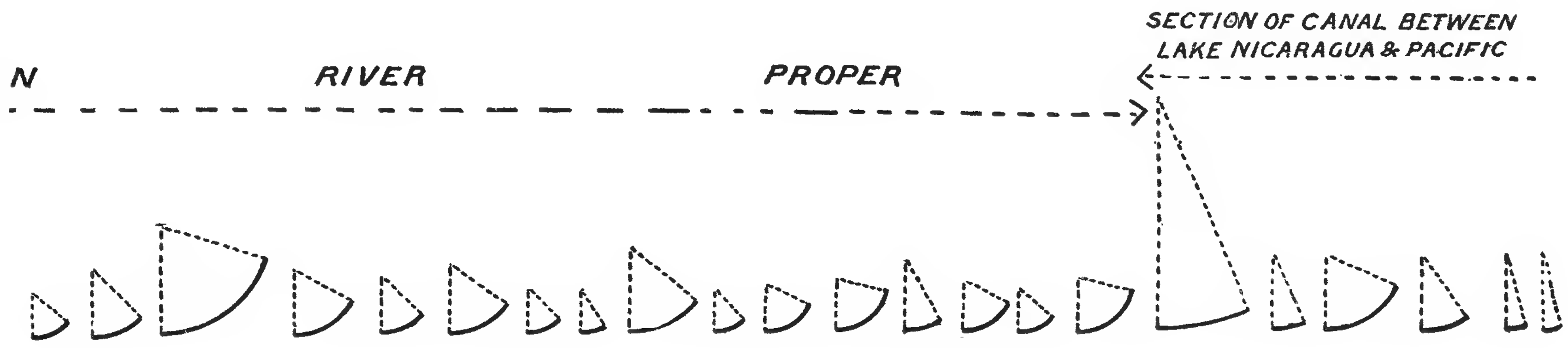
RELATIVE FREQUENCY OF GREAT SEISMIC DISTURBANCES IN THE THREE VOLCANIC GROUPS OF GUATEMALA, SALVADOR, AND NICARAGUA.

From the statistics produced by Mr. Bertrand, member of the Institute of France, in relation to the number of great volcanic explosions or exceptionally violent earthquakes recorded before the beginning of the nineteenth century and from that time to 1885, in the three powerful volcanic groups of Central America, Guatemala, Salvador, and Nicaragua, I have calculated that before the beginning of the nineteenth century 45% belonged to Guatemala, 35% to Salvador, and 20% to Nicaragua; and that the corresponding figures for same groups were in the nineteenth century 30% for Guatemala, 45% for Salvador, and 25% for Nicaragua, which demonstrates a displacement towards Nicaragua of the maximum of seismic activity, as is shown by comparing the two dotted curves, which can be considered as representing the intensity of volcanic activity along the line of volcanoes from North Guatemala to South Nicaragua.

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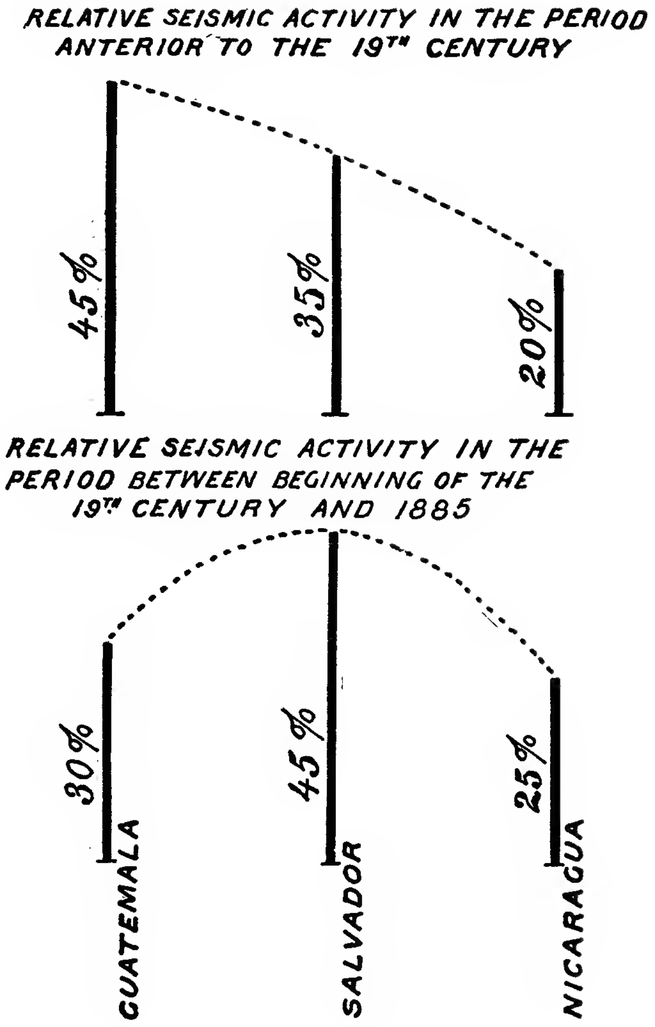

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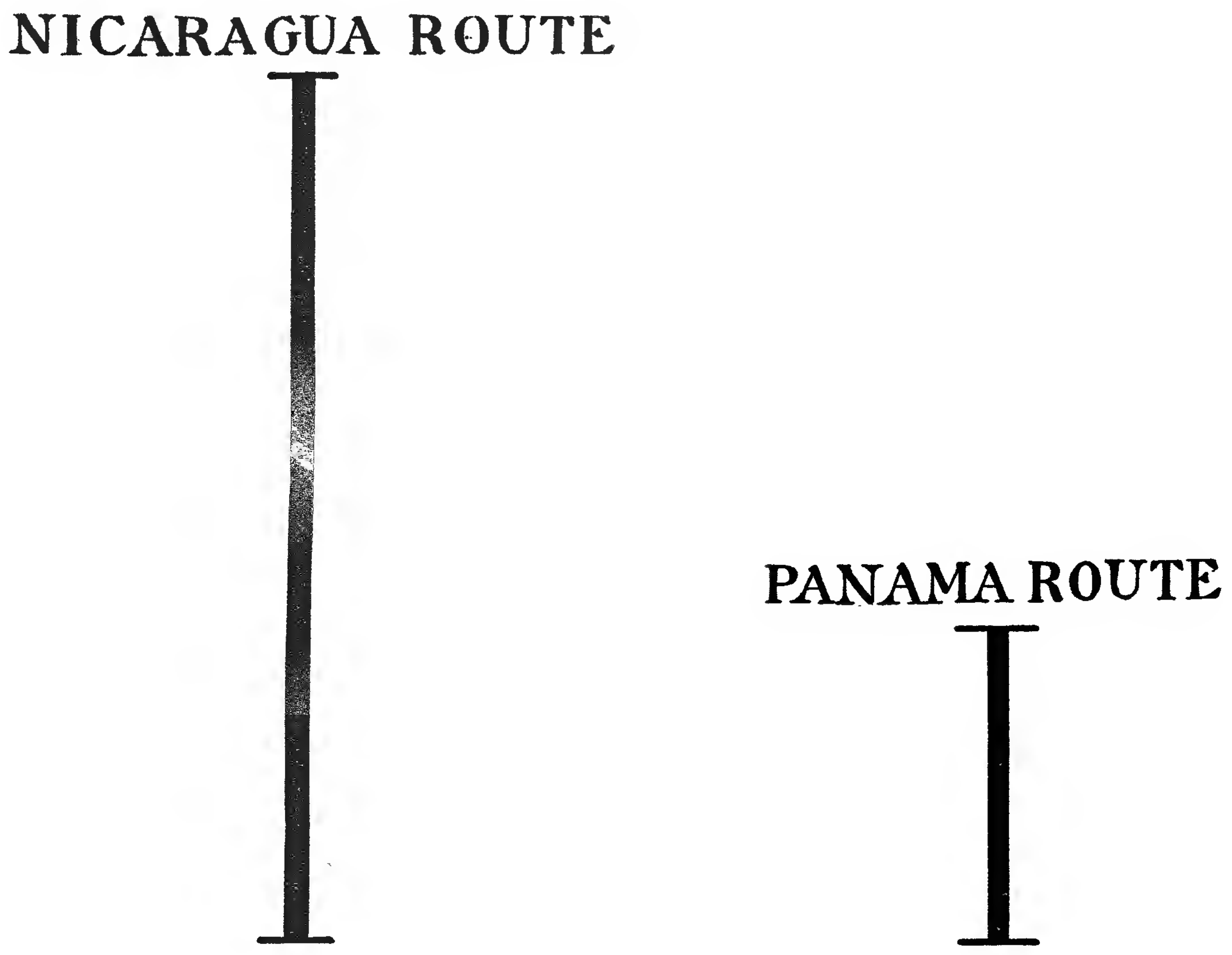
PANAMA ROUTE

RESPECTIVE DEPTHS OF GREAT CUTS ON THE NICARAGUA AND PANAMA ROUTES.

THIS plate gives, drawn at the same scale of one inch for sixty feet, the respective depths of great cuts that are to be dug on both routes.

On the Nicaragua route, according to the figures of the Isthmian Canal Commission, the greatest cut is at Tamborcito, and is 297 feet deep.

On the Panama route the Culebra ground, originally 274 feet above the bottom of the Culebra cut, according to the project adopted by above named Commission, is to-day reduced to 110 feet, owing to the works executed by the old and the new Panama Company.



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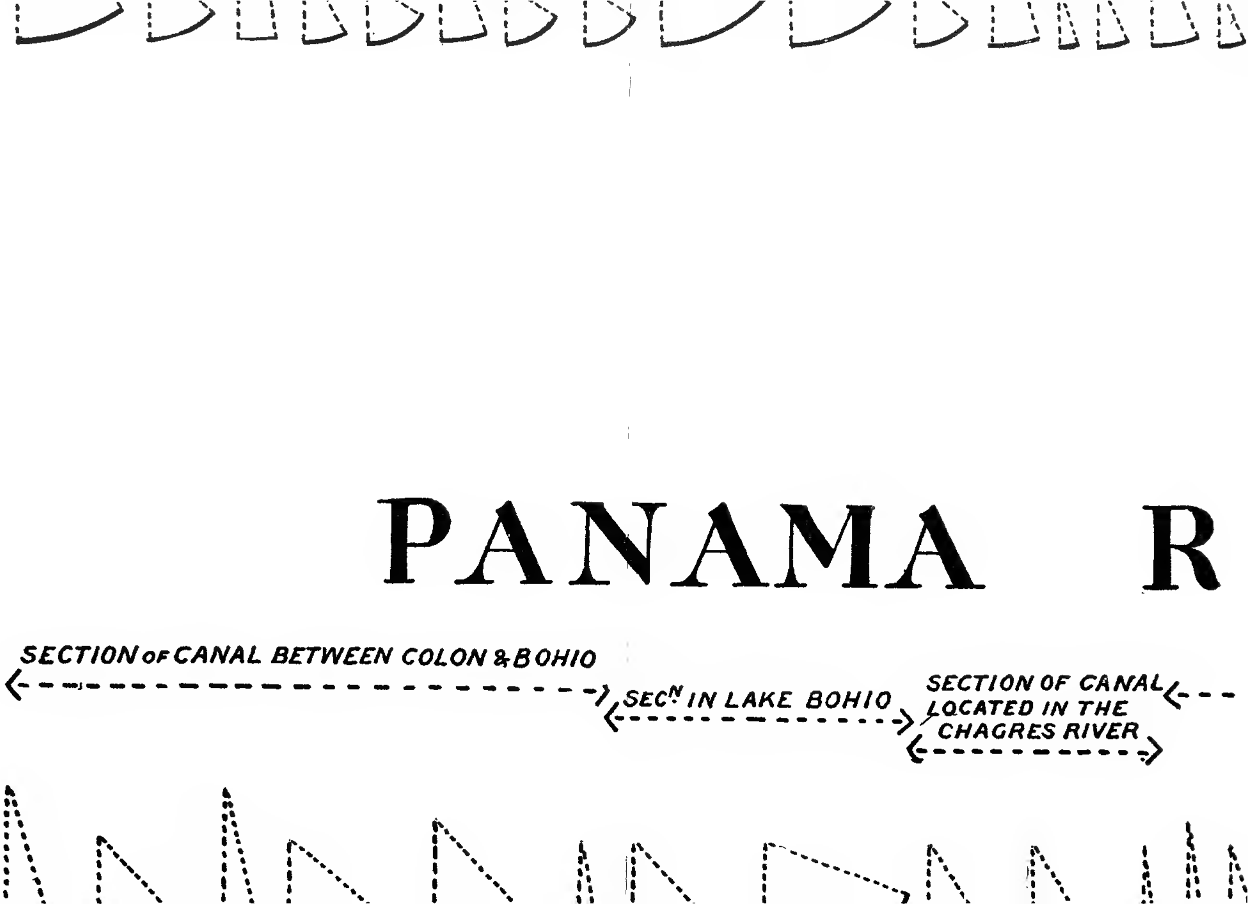
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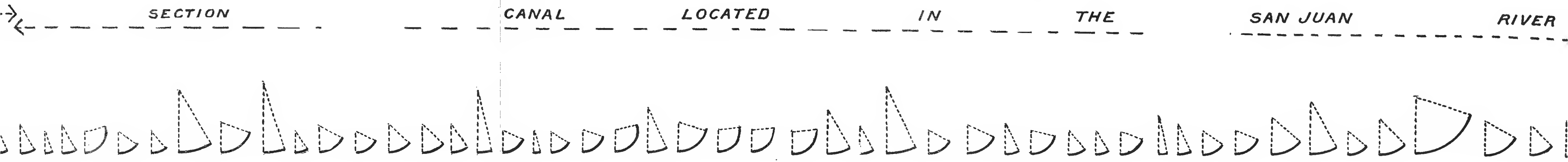
NICARAGUA ROUTE



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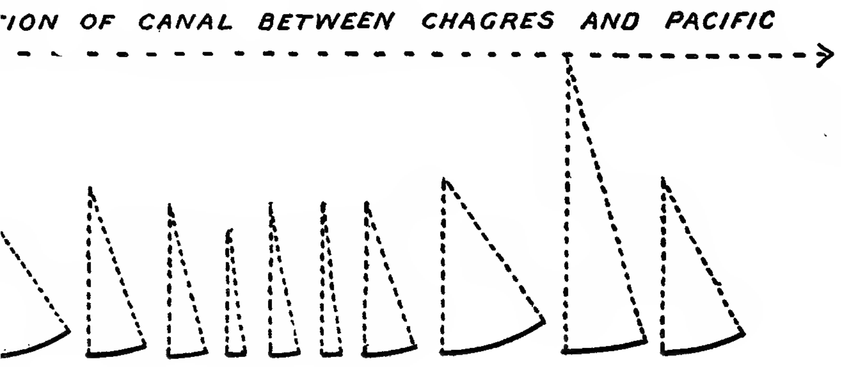

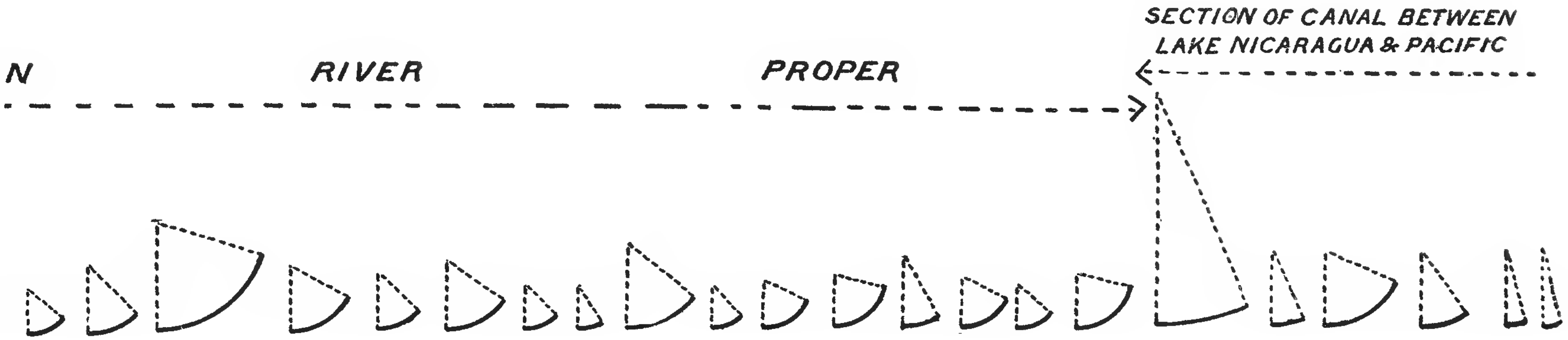
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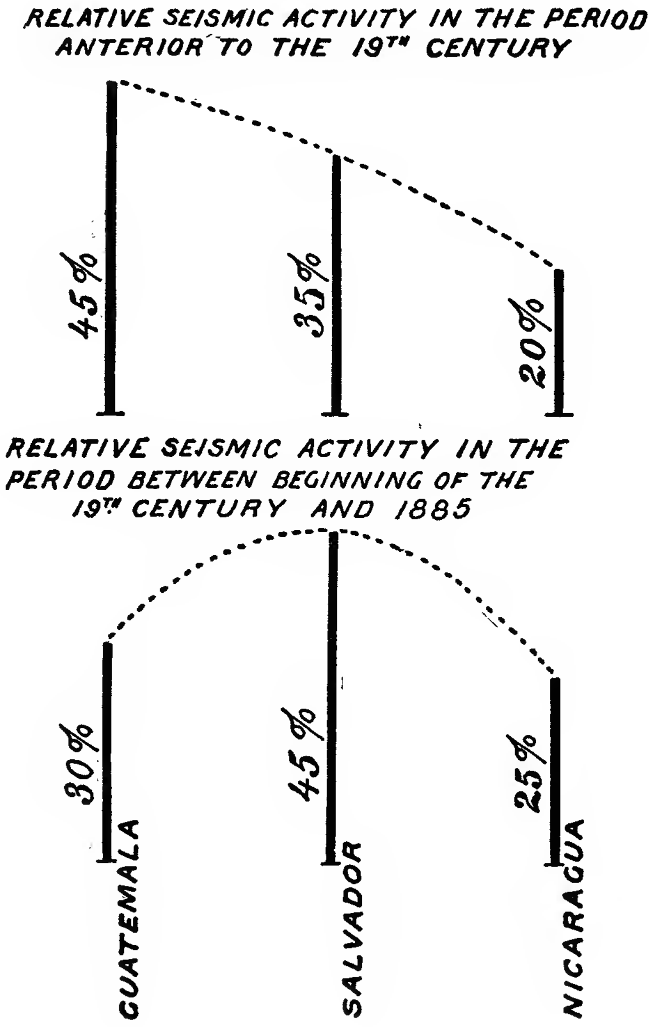

CURVES ON THE NICARAGUA AND PANAMA CANAL ROUTES.

THIS plate gives the successive curves that would be met by transitting ships on the Nicaragua route* and on the Panama route, drawn at the same scale, one inch for 12,000 feet, together with their respective radii and their distribution in the different sections of each canal, leaving aside the curves in harbors or at the entrances of locks, where ships have a very reduced speed.

The consideration of the curves of the Nicaragua route will show how numerous and sharp the curves are in the section of the Nicaragua route where the Canal will be located in the San Juan River proper, in whose bed an artificial channel has to be opened for a total length of 27.96 miles, through sand and silt to a depth of sixteen feet below the bed (for the larger part). It must be borne in mind that ships steering around these curves will at the same time have to meet not only the river currents but also the abnormally heavy, continuous winds of the San Juan Valley and the dredges that will have to keep open the artificial channel in that big river, whose floods are estimated at 100,000 cubic feet a second, and whose measured mean discharge was, from July to December. 1898 (a comparatively dry year),† 31,000 cubic feet a second, the average monthly maximum being 45,500 cubic feet a second, and the highest maximum 70,000 cubic feet a second.

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THE TEXT OF A LECTURE BEFORE THE COMMERCIAL CLUB OF BOSTON,

BY

PHILIPPE BUNAU-VARILLA,

ON THE

PANAMA CANAL.

(25th of February, 1909).

Reprinted from Congressional Record, Sixtieth Congress, Second Session,
Senate, Tuesday, March 2, 1909.

The Text of this lecture was introduced by Mr. Foraker, Senator from Ohio,
during a speech of Mr. Teller, Senator from Colorado, on the
Panama Canal. Mr. Foraker moved that it should
be printed in the Record and also
printed as a Senate document.
The Senate so ordered.
(see over.)

The text of the lecture before the Commercial Club of Boston is followed by a supplement bearing on some important points which were to form part of the lecture, but which had to be omitted for lack of time. Also, a third chapter has been appended. It is formed by extracts from testimonies given at Ancon, Canal Zone, before the Congressional Committee on Interstate and Foreign Commerce, in which facts of the highest importance are set forth. They form, so to say, a corroborative evidence of the statements made in the lecture.

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[Extract from Congressional Record, Senate, Tuesday, March 2, 1909.]

Mr. FORAKER. I have before me a report made by M. Bunau-Varilla before the Commercial Club of Boston only a few days ago, on February 25. In the course of his remarks, speaking of the foundation of the Gatun Dam, as I understand, he quotes from Colonel Goethals, in which he says:

"The rock of the upstream toe has sunk about 20 feet in height and 200 feet in length where it crosses the canal. In sinking it has squeezed out and pushed up the clay underneath."

I understand that in the construction of the Gatun dam it was provided that there should be a "toe," as 't is called, constructed of stone at the base of the dam. The dam is half a mile broad, I believe, at the base, where the water is impounded. They commenced the work by constructing the toe of the dam, and when they got it 65 feet high it sunk down 20 feet for a distance of 200 feet.

Mr. BEVERIDGE. Why?

Mr. FORAKER. Because the foundation was of such a character, as he goes on to point out, that it would not sustain that weight. That seems important, Mr. President. This speech was handed me only this morning and I have been reading it as I have been sitting here in the Chamber to-day. I find it, to my mind at least, very instructive. I think the Senate and the country ought to have the benefit of it, and if the Senator does not object, I would like to have it printed in the RECORD, and will ask that it also be printed as a Senate document.

Mr. HOPKINS. Mr. President——

Mr. HALE. I ask the Senator——

Mr. TELLER. I decline to yield to the Senator from Illinois.

The VICE-PRESIDENT. The Senator from Colorado declines to yield. Is there objection to the request of the Senator from Ohio [Mr. FORAKER] that the document to which he refers be printed in the RECORD and also be printed as a public document.

Mr. HOPKINS. Mr. President, I dislike very much to object, but I think that statement ought not to go nto the RECORD without a counterstatement going with it. I was not aware that this——

. . . .

Mr. FORAKER. Mr. President, I do not want to take the time of the Senate away from the consideration of the deficiency appropriation bill or any other bill that is reported; certainly I do not want to delay any of these matters; but I apprehend that the question which the Senator from Colorado [Mr. TELLER] is discussing s about as important as any other that is before the Senate, and even more important.

I do not know what ought to be the determination with respect to the Panama Canal. I only know, as I stated in the Senate some days ago, that I voted for a lock type of canal with some misgiving as to the wisdom of that vote. I have had that same misgiving ever since. I tried when there was an additional report made a few days ago to dismiss from my mind any further misgiving about it; but since then I have seen a number of facts stated in the press that have caused me to recur to that same state of mind. When I read this address made by Bunau-Varilla before the Commercial Club of the city of Boston only a few days ago—I read it here in he Chamber only this afternoon—my mind again went back, without any misgiving whatever, to the state of doubt, at least, in which it was before. I fear a great mistake will be made if the construction of a lock type of canal is insisted upon; but I am not prepared to discuss that and would not ask the Senate to bear with me that might do it at this late day in the session; but I think the Senate ought to have the benefit of what this engineer has said. All that he says he backs up, it seems to me, with data that you will find conclusive in character, and I hope the Senator from Illinois will not object to this being put in the RECORD. If he should I shall have to read it.

Mr. TELLER. I will put it in my speech.

Mr. BAILEY. Mr. President——

The VICE-PRESIDENT. Does the Senator from Colorado yield to the Senator from Texas?

Mr. TELLER. Yes.

Mr. BAILEY. I should like to ask the Senator from Ohio if that is the same person who was the first duly accredited minister from the Republic of Panama to the Government of the United States?

Mr. FORAKER. I understand he is. I do not know what his standing ought to be either as a minister or as an engineer, but I have always heard that he stands very high as an engineer throughout the world, in the estimation of men who are competent to judge. At any rate, what he says here can not do anybody any harm, and it might do some good.

Mr. HOPKINS. Mr. President——

The VICE-PRESIDENT. Is there objection to the request of the Senator from Ohio?

Mr. BAILEY. I do not know how much of an engineer he is, but I think he is a most accomplished diplomat, for, as I understand, he is one of the few men who has had his credentials cabled to him.

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Mr. FORAKER. I desire to say one word in answer to the Senator from Illinois [Mr. HOPKINS]. I have not offered any paper or any remark in any controversial sense. I think we ought to get all the information we can of every character in regard to this matter. It is not so important to me as it is to Senators who remain n the public service. I go out within a few days. They remain. If I were to remain here, I would get, and hey ought to have, all the information obtainable, and I make the request for no reason in the world except that he Senate should have all the light it could get.

Mr. HOPKINS. In view of what the Senator from Ohio says, I shall not interpose the objection that it was my intention to make. I do not attach the importance to the speech that the Senator from Ohio does, and the criticisms I have heard made upon it satisfy me that it is entirely unreliable. But in view of the position taken by the Senator from Ohio, as I say, I shall not object to its being printed in the RECORD.

Mr. FORAKER. The Senator can do no greater service to the Senate and the country than by showing that it is unreliable. Until he or somebody else does show it is unreliable it is bound to make an impression, I think, on the minds of fair-minded men

Mr. HOPKINS. In response to the Senator from Ohio I will say that I was not aware that this debate was o come up to-day. I have material on this subject which I think will be of interest to the Senate and the country. Had I supposed that it was to be discussed in the manner it has been presented I should have been here to present the other side.

The VICE-PRESIDENT. Will the Senator from Ohio restate his request?

Mr. TELLER. I will ask it, because I have some papers of the same kind. I have an article written by a very distinguished engineer in this country, who knows all about the canal. It is written in good temper and proper spirit. I ask that it may be printed in the RECORD in connection with the paper presented by the Senator from Ohio.

The VICE-PRESIDENT. Without objection, permission is granted.

Mr. FORAKER. I make the further request that the address delivered by M. Bunau-Varilla may be printed as a document.

The VICE-PRESIDENT. Without objection, it is so ordered.

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[Extract from Congressional Record, Senate, Tuesday, March 2, 1909.]

Mr. FORAKER. I have before me a report made by M. Bunau-Varilla before the Commercial Club of Boston only a few days ago, on February 25. In the course of his remarks, speaking of the foundation of the Gatun Dam, as I understand, he quotes from Colonel Goethals, in which he says:

"The rock of the upstream toe has sunk about 20 feet in height and 200 feet in length where it crosses the canal. In sinking it has squeezed out and pushed up the clay underneath."

I understand that in the construction of the Gatun dam it was provided that there should be a "toe," as t is called, constructed of stone at the base of the dam. The dam is half a mile broad, I believe, at the base, where the water is impounded. They commenced the work by constructing the toe of the dam, and when they got it 65 feet high it sunk down 20 feet for a distance of 200 feet.

Mr. BEVERIDGE. Why?

Mr. FORAKER. Because the foundation was of such a character, as he goes on to point out, that it would not sustain that weight. That seems important, Mr. President. This speech was handed me only this morning and I have been reading it as I have been sitting here in the Chamber to-day. I find it, to my mind at least, very instructive, I think the Senate and the country ought to have the benefit of it, and if the Senator does not object, I would like to have it printed in the RECORD, and will ask that it also be printed as a Senate document.

Mr. HOPKINS. Mr. President——

Mr. HALE. I ask the Senator——

Mr. TELLER. I decline to yield to the Senator from Illinois.

The VICE-PRESIDENT. The Senator from Colorado declines to yield. Is there objection to the request of the Senator from Ohio [Mr. FORAKER] that the document to which he refers be printed in the RECORD and also be printed as a public document.

Mr. HOPKINS. Mr. President, I dislike very much to object, but I think that statement ought not to go nto the RECORD without a counterstatement going with it. I was not aware that this——

. . . .

Mr. FORAKER. Mr. President, I do not want to take the time of the Senate away from the consideration of the deficiency appropriation bill or any other bill that is reported; certainly I do not want to delay any of these matters; but I apprehend that the question which the Senator from Colorado [Mr. TELLER] is discussing s about as important as any other that is before the Senate, and even more important.

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COMMERCIAL CLUB OF BOSTON.

LECTURE OF MR. BUNAU-VARILLA

ON

THE PANAMA CANAL

(25th February, 1909.)

GENTLEMEN:

It is for the second time that the Commercial Club of Boston extends to me its gracious hospitality. The first instance was when this country had to choose between Panama and Nicaragua for the establishment of the great maritime highway of nations.

I came to America, in the beginning of 1901, to develop publicly the scientific arguments, which in my opinion demonstrated the impossibility of the Nicaragua solution.

After the lecture which I gave in this Club, Mr. Lucius Tuttle, who presided over the meeting, expressed, in the following words, the impression it had made upon his mind. "I see "that with the Nicaragua project we have opened the switch "on the wrong track. It leads to a precipice—we must stop, "go back and take the other track."

This is just what happened. I need not recite the events which seem more to belong to romance than to reality, and which finally led to the defeat of the Nicaragua solution; the splendid fight in the Senate by that great citizen Senator Mark Hanna, whom I had met through my friend Governor Myron T. Herrick of Cleveland and whom I had succeeded in making the firmest believer in the Panama solution; then the secession of Panama, the formation of a new republic which entrusted me as Minister Plenipotentiary, the representation before the United States and all the nations of the world, of its vital interests which were those of the construction of the canal over its predestined territory.

Tomorrow there will be five years since I exchanged with your great statesman John Hay the ratifications of the treaty by which the Panama Canal, like the Phœnix of the fable, was to be born out of its own ashes.

And today I come again before you as I did eight years ago to tell you, and through you the people of the United States, that the switch has been opened on a wrong track, that it leads to a precipice, that it is time to stop, to go back and to follow the other track.

The essential question at issue is that of the stability of the Gatun Dam.

You know in its general lines the project actually under construction. It consists in creating, on both sides of the continental backbone, a great lake by damming near the oceans the valleys of the two rivers which come from the Cordillera. It consists in opening the continental backbone at such a level as the two lakes will freely communicate between each other. It consists finally in establishing, near each of the two dams, flights of locks which will allow ships to rise from the level of one ocean to that of the lakes, say 85 feet, and after crossing the lakes to descend from the level of the lakes down to the level of the other ocean.

Of course each of these two dams is essential. If it breaks and disappears under the pressure of the water and its torrential escape, the essential element of the canal will also have disappeared. There will not be any more possibility of passing a ship than there is today.

This conception of the canal at Panama is the child of the conception of Nicaragua : a big lake suspended above the oceans at a level of 100 feet, more or less, to which ships will have access by means of these steps for ships, which are called locks.

It came into the world in 1879 during the International Congress called by Mr. de Lesseps, and where the different solutions of the Isthmian Canal clashed.

Mr. Godin de Lepinay was its inventor. Nobody then thought of but one process for excavating the canal, the digging in the dry by steam shovels and trains. Mr. Godin de Lepinay knew very well of the difficulties of the tropics and he proposed the lake and lock system, which is actually in course of execution. He founded the justification of his project precisely on the very same arguments which are today invoked in its favor against the sea-level plan, that is against the narrow canal which is freely open on the Atlantic, which has no tides, and which is closed on the Pacific side by tide locks in order to prevent the tidal variation of level of this ocean to cause currents which would be objectionable in a narrow canal.

Godin de Lepinay fixed 24 meters above the oceans for the level of the lakes, say 79 feet. He proposed the location of Gatun for the dam on the Atlantic, but he at the same time gave warnings of the possible danger of its construction.

At the very instant of its birth in the engineering mind in 1879 the Gatun dam was denounced by him who had conceived it as dangerous.

The actual lock and lake plan adopted by the minority of the Consulting Board in January 1906, textually reproduced the proposition of Godin de Lepinay of 1879. The level of the lake was fixed at 85 feet and the Gatun location for the dam was adopted on the Atlantic side, when on the other hand the La Boca location was selected for the dam on the Pacific side.

Had anything happened between 1879 and 1906, which could have been invoked in favor of the stability of a dam at Gatun?

Nothing! On the contrary. The intimate knowledge of the formation of the Isthmus, of the character of its soil which resulted from a battle of more than seven years against nature, during which 72,000,000 cubic yards were excavated in the middle of a constant epidemic of yellow fever, demonstrated that a dam at Gatun would be in the worst condition an engineer could dream of.

The great difficulty we had to contend with was precisely the particularly slippery and treacherous nature of the soft clay resulting from the weathering of the solid mass of the Isthmus, brought by the waters in infinitesimal particles and deposited all along the canal. It was the most difficult material and the most slippery that could be imagined.

During many months I was in doubt if it was really possible to dig through that mass of clay, as slippery as soap, which formed the superior strata of the Culebra cut.

Nobody will ever know what efforts, what anxiety it has cost us to pierce and to remove this mass of soft ground and to reach the solid core of the Culebra cut in which the actual workers can establish solid tracks on a firm soil.

The conditions we found on the highest point of the canal cut, at Culebra, are the same at the lowest point, at Gatun, but there the accumulation of this soft and slippery material is below the level of the ocean; it is in the subsoil.

I met it when I opened the canal in that region. The clay, which the buckets of the dredges attacked in the bottom of the canal, was so sticky and plastic that very often it moulded itself into the buckets in such a way as to refuse to fall down; the dredges had to be stopped and men placed all along the bucket chain to dig with shovels into the buckets, and to empty them.

This is why I looked upon, and I am looking with so much concern upon a dam at Gatun seated upon these slippery strata.

The very first time I heard of a revival of the idea of a dam at Gatun was by a note from Mr. Alfred Noble asking my opinion about constructing a lake, dam and lock canal with dams at Gatun and at La Boca. It was on the eve of my departure for France, five years ago after exchanging with Mr. Hay the ratifications of the treaty under which the canal is now constructed, the so-called Hay-Bunau-Varilla treaty.

I replied offhand to Mr. Noble that there was no probability of finding foundations at either place, but especially at Gatun.

The events have justified this opinion, as soundings have shown that bedrock at Gatun was about 260 feet below sea level and because they have also revealed that above the bedrock exists an enormous mass of blue clay which can under no pretense possible be called legitimately a foundation even for an earth dam.

When the minority of the International Consulting Board revived in January, 1906, the old plan (lake, dam and lock) of Godin de Lépinay, already deemed an inadequate solution in 1879 and adopted the location at Gatun for a dam in spite of the warnings of the creator of this conception himself, the majority of the Consulting Board protested against such a dangerous experiment.

I protested also in a public letter to President Roosevelt, dated March 5th 1906, which was reproduced by the daily papers, against the instability of the huge Gatun dam. As the method of construction adopted was an entirely new one, which I had described to the Consulting Board at the beginning of its works, as was registered in its report (page 213). I felt bound to reject all future responsibility and " to expressly " disapprove, from a scientific standpoint, the use of that " method, very good for a small, low and temporary dam, " highly dangerous for a huge dam of more than 20,000,000 " cubic yards in volume in a country frequently shaken by " earthquakes."

At the very beginning of the construction of the dam at La Boca by Colonel Goethals, the difficulty of carrying out the plan and the method of construction was such that the location adopted was abandoned for that of Miraflores some miles higher up the valley.

This necessity of abandoning the La Boca location was reported on December 9th, 1907 by the Chief Engineer of the Canal, Colonel Goethals. The change was approved by the President on December 20th and published in the Canal Record in the number of December 25th following.

It was nature which at this moment added its first warning to that of men.

Nature gave a second and recent warning when the construction of the Gatun dam began last year.

The first work undertaken was to construct along the foot of the dam on the lake side an embankment of stone, the part of which was to sustain the earth which will constitute the body proper of the dam.

The Canal Record of November 11th, 1908, stated that this embankment (called also the rock toe of the dam) was about completed at a height of 60 feet above sea level. But on the 25th November a cablegram from Colonel Goethals announced that it had given way at the crossing of the old french canal and that it had lost 20 feet of its height on a distance of 200 feet.

I knew what ground was there at the bottom of the old canal, for I opened it myself, and I expected the first warning of nature would come in that neighborhood. It therefore did not surprise me in the least. I considered it an ominous but providential Mene, Mene, Tekel, Upharsin written by nature on the bottom of the future Gatun dam. I gave my views to the Herald and to the Figaro in Paris and they were published on the 12th of December in New York.

Soon after, as you know, it was made public that the President elect, Mr. Taft, intended to go to the Isthmus with a body of consulting engineers and that Colonel Goethals had been invited to make a reply to me.

As you know also the results of this consultation was entirely favorable to the Gatun dam. It was found to be not only safe, but exceedingly so and therefore it was advised to reduce by 20 feet the height of the dam above the level of the lake, which height above the water had been originally fixed at 50 feet, in order to form a margin of security against any possible contingency such as a tidal wave in the lake due to an earthquake or a settling of the dam similar to that which happened to the rock toe.

It was formally denied that this modification had been inspired by the desire of diminishing the weight of the dam upon its base of soft clay. The reason advanced was the desire to make a little economy in the structure.

Gentlemen, if in such a grave matter a jocular reminiscence could be admitted, I would tell you the story of that Spanish tailor who one day saw a very tall customer enter his shop and ask for a cape. He realized that he had none in the store for such a tall man. However, he took the longest cape he had and put it on the shoulders of his client. Before the purchaser had time to examine if the cape fitted him, the tailor had jumped to his scissors and putting himself in the attitude of cutting the lower part of the cape, he said: "This cape is decidedly too long for you. I am going to cut "it a little." "Oh," answered the client, "don't cut it, it is "not too long, it is all right so," and he bought it and went. I hope you will excuse this jocular story, but I cannot help remembering it when I speak of that astonishing decision of modifying the design of an earth dam on account of the excess of its stability.

This is the first time in my life of engineer that I ever heard of an excess of stability for an earth dam.

But, however, the question has been settled, the Government has spoken its last word. It has been said to be so final that any further discussion would have to be ascribed to opposition against any canal.

The New York Tribune, which generally expresses the views of the administration said in an editorial : " We have " no idea that all Americans, or all expert engineers, or all sin- " cere friends of the canal, will be convinced by this report " and will be persuaded that the sea level plan is not the best. " But at least it should be possible for reasonable men to " credit these expert engineers with professional acumen and " prudence and with entire sincerity and to place reliance " on the judgment of the administration which is responsible " for the great work and which must bear the blame of failure " or disaster if any should befall it. It seems to us high time " for dissension and doubt to give place to a cordial support " of the canal enterprise and to a cheerful confidence in its " success."

These are very wise thoughts and I have meditated upon them. They should be listened to and obeyed if the question was a mere question of more or less perfection, of more or less expenditure, if it was simply one of those questions of philosophy, of economics, of politics, which once settled, even badly settled, must be dismissed from public discussion at least for the time being.

But this question is different ; it is a question of life or death for this work which humanity is longing for since centuries. If, as I think, the fact is written in advance, that the Gatun dam will give way, can I give it a cordial support and enjoy a cheerful confidence in its success ? No, that is impossible. It is also impossible to stay silent until I have exhausted all possible means to drag the truth out of her well and to show her. It seems to me that I would be a treacherous friend of this great country, a double faced flatterer of President Roosevelt if I acted so.

I may lose the friendship of this great American and also his confidence. I shall have lost something to which I attach the highest value, something of which I am very proud.

Nothing will deter me however from doing my duty, and as Colonel Picquart said in the most trying phase of the Dreyfus affair "I shall not go to the grave with that burden on the "heart."

I propose to lay bare before you all the direct and circumstantial evidence which prove that the Gatun dam is an unstable structure and that the experts who recommended it have made and are making a terrible mistake. I shall speak openly without the slightest shadow of bitterness against any of these prominent engineers whom I individually respect. If I confront facts with opinions it is simply in order to generate by their friction the spark which will throw light on that obscure question.

As I told you the first man who thought of erecting a dam at Gatun, Godin de Lepinay in 1879, was also the first man who doubted its possibility. He never spoke of it later on.

As I told you already also, the dredging of the bottom of the canal brought to light in 1885 this sticky, plastic, soft, slippery blue clay which will underlie the dam to a great depth on more than one-third part of its length.

As I told you, this personal experience as well as the general and practical knowledge of the formation of the Isthmus led me to write to Mr. Noble in the first days of March, 1904, that no foundations for a dam would be found at Gatun.

These are disinterested testimonies before there were any talks of erecting a dam at Gatun. They were not influenced therefore by any passion generated by the heat of a technical controversy.

In January, 1906, the minority of the consulting board recommended a dam at Gatun and another, or rather a couple of others, on the shores of the Pacific, the principal one being at La Boca, across the mouth of the Rio Grande river. The pressure exerted on the ground at the base by the embankment which constitutes the dam was declared in their report to be six and a half tons per square foot at Gatun. The minority report was signed by M. M. Alfred Noble, Henry L. Abbot, Frederick P. Stearns, Joseph Ripley and Isham Randolph.

The majority of the board was formed by Gen. W. Davis, Messrs. Wm. Barclay Parson, Wm. H. Burr, Wm. Henry Hunter (named by the English Government), Ad. Guerard (named by the French Government), Eugene Tincauzer (named by the German Government), J. W. Welcker (named by the Dutch Government), E. Quellennec, Chief Engineer of the Suez Canal.

The majority said textually on the La Boca and Gatun dams: " The board is therefore of the opinion that the existence of " such costly facilities for the world's commerce should not " depend upon such reservoirs held by earth embankments " resting literally upon mud foundations or those of even sand " and gravel. *The Board is unqualifiedly of opinion that no " such vast and doubtful experiments should be indulged in.*"

The minority in its report defended the earth embankments on the ground that no seepage could occur owing to the nature of the soil of the embankment and that of the subsoil. And in this it was correct, provided both would remain in place. Nothing was said to relieve the mind of the fear that the softness of the foundation might generate movements of mass infinitely more dangerous than percolation because they are bound to leave large fissures into which water will immediately penetrate in great quantities.

As soon as the project was adopted I denounced in a public letter the unstability of the huge Gatun dam as I said already. But not being willing to bring again the foundation question, which I had opened in 1904 with Mr. Noble and which had been dealt with most completely in the majority report, I further indicated the peril of fissuration by slight earthquakes of the earth dam which means an immediate washout of the dam. This was not a pure hypothesis. In 1882 all the surface of the earth in Colon, that is, in the immediate neighborhood of Gatun, was fissurated by an earthquake and the record of this ominous fact is in the Isthmian Canal Commission's report of 1901.

Such were the opinions brought forward by the various parties engaged in the contest and which were : the minority defending the lake and lock plan which might be termed the third class solution, the majority defending the narrow sea level canal with tide locks on the Pacific, which might be called the second class solution, and myself defending what might be called the first class solution, the perfectly free, open, wide, deep passage between the oceans entirely freed from any artificial structures such as locks and dams. This is what I called the "Straits of Panama" in order to distinguish it from the narrow, tide locked "Sea Level Canal."

Now if the minority was right or wrong in its conclusions the subsequent facts must show. If it was accidentally wrong on one point and right on the generality this can be condoned. But if a continuous series of facts demonstrate that a general error pervades all its works, then the greatest caution is required and just suspicion is cast on its views on a point for which a correct judgment is essential because it commands the whole situation.

This will be what might be called the circumstantial evidence against the Gatun dam after enumerating the independent testimonies anterior to any project of a dam at Gatun.

FIRST ERROR OF THE MINORITY. The principal argument in favor of adopting the third class solution, the lake, dam and lock plan, was its reduced cost. It was set forth at $139,000,000. It is now fixed at $297,000,000 and it is not yet finished. This figure excludes all the items excluded from the original evaluation of $139,000,000. If we include them it reaches $375,000,000.

SECOND ERROR OF THE MINORITY. In fixing the dimensions of the locks for future increase of ships they decided for their length to adopt 900 feet and for their width 95 feet. In fixing these figures they said it was not necessary to adopt respectively 1000 feet and 100 feet, as the majority did for its tide lock in the sea level canal, because "no " one would expect to provide in any commercial or military con- " struction for needs at the end of the present century." One century has not lapsed since 1906 and, however, the dimensions of 900 by 95 have not only been found already too small but even those of 100 by 1000 feet have been found so. The present rectified dimension adopted are 110 by 1000 feet.

THIRD ERROR OF THE MINORITY. This error is also shared by the majority. The great question which had really inspired in Godin de Lepinay the idea of a lake, dam and a lock canal in 1879 was the extreme difficulty and cost of excavation by steam-shovels and trains under the conditions created by the terrible rainfalls in the tropics. His aim was simply to reduce the amount of excavation by raising the level of the passage through the backbone of the Cordillera. But since a new method of excavating the rock was started which absolutely eliminates the difficulties of cost and of time. It consists in dredging the rock under water after having broken it in pieces as large as a man's head. I started this new principle in 1885 on the canal with a new method of mining. Later on the method was developed on the Suez Canal by the substitution of mechanical concussion to dynamite explosion. It is now perfected and gives results which are astonishing as to celerity and economy in the largest public works on earth, such as the Suez Canal and the Manchester Ship Canal.

In 1901 the Isthmian Canal Commission had fixed the removal of rock under water at $4.75 a cubic yard.

I showed to the Consulting Board that it was now demonstrated to be infinitely lower, but they still fixed the price at $2.50 for the removing of one cubic yard of rock under water when the cost of ordinary dredging was placed at fifteen cents.

These two prices show that the preliminary operation of breaking one cubic yard of rock was fixed at two dollars thirty-five cents.

One year and a half later before the Institution of Civil Engineers of London, in June, 1907, special and official reports have shown that the actual cost of that operation had been in reality twenty cents a cubic yard in the Suez Canal and in the harbour of Blyth and twelve and one half cents in the Manchester Ship Canal.

This third error of the Consulting Board, in fixing a price more than eleven times too great if the Suez Canal is taken as the standard and more than eighteen times too great if the Manchester Ship Canal is taken as the standard, has entirely thrown out of consideration the only economical and powerful method by which the canal can be constructed, not only as a narrow canal at sea level, but as a veritable wide and deep Straits. It is this deplorable error which has led the United States into the wrong way and enticed them to take the most inferior, the third class solution, when the perfect, the first class solution, could be obtained at a less cost.

FOURTH ERROR OF THE MINORITY. As we have seen, they recommended the erection of a dam of earth at La Boca on the Pacific. Their sincere but erroneous conviction was such that it had passed into the minds of the engineers in charge of the construction on the Isthmus.

President Roosevelt on his return from the Isthmus wrote in his message of December 17, 1906: " La Boca dam offers " no particular problem, the bottom material being so good " that there is a practical certainty not merely as to what can " be achieved, but as to the time of achievement."

The Secretary of War, Mr. Taft visited the Isthmus some months later in the spring of 1907. He was accompanied by two of the engineers who had signed the lake, dam and lock plan, Messrs. Noble and Stearns and by a third engineer of considerable reputation, Mr. Freeman of Rhode Island, who was also invited to add his advice to that of the former members of the minority of the Consulting Board.

They declared on their return with Mr. Taft, that everything was all right and that the La Boca dam was a certain success, just as the Board which recently came back with Mr. Taft, declared that the Gatun dam was perfect. They did not, however, go as far as saying, as the recent Board was reported as having said about the Gatun dam, that it was unnecessarily strong and had to be modified for that reason. (The board which went with Mr. Taft this year consisted of six members, three of whom had already been associated with the present plan—Messrs. Stearns and Randolph who signed it and Mr. Freeman who approved it a year later (1)).

The Board of 1907, that is, Messrs. Noble, Stearns and

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(1) A seventh member was added at the last moment to the six first ones.

Freeman reported about the La Boca dam as follows (Canal Record of Wednesday, December 25th, 1907):

" The borings showed a so-called mud in the swampy sec-
" tion having a depth of 8 to 10 feet. This material is firmer
" than we had expected and at the time of our visit, about two
" days after it had been flooded by spring tides, it could be
" walked on in most places.

" *For the dam construction we do not think it will be*
" *necessary to remove the soft material at either of these*
" *places.* (Sosa Corozal and Sosa San Juan). The very softest
" material will either be displaced or consolidated by the
" material disposed on it. We do not think the amount dis-
" placed beneath the impervious portion of the embankment
" will be great and if compressed in place the material will be
" impervious."

Thus spoke in 1907 the experts who had signed the plan in 1906 and the new expert, Mr. Freeman, who had joined them for the purpose of verification.

Now, let us look at the facts as described by the Colonel Goethals in the report of December 1907 to the Secretary of War, which was also inserted in the Canal Record of December 25th, 1907.

" To construct the dam according to these views, trestles
" were built along the toes of the Sosa Corozal dam from which
" to dump material from the Culebra cut. The trestles failed
" after the dumping of the material from them began and the
" material overlying the rock moved laterally carrying the
" superimposed mass with it, the dumps flattening out until
" the side slopes where about one on twelve or even less.

" In places this lateral motion continued for two weeks after
" dumping had stopped, the ground on either side of, and at
" some distance from, the dump was forced up forming mounds
" of mud, the crests of which gradually approached the level
" of the top of the dump proper. After an equilibrium was
" established between the dump and the adjacent mounds, the

“ hump or wave would again move out when the track was “ shifted towards it accompanied by a sudden vertical settling “ of the track of six to ten feet where loaded trains were applied. It was thought that if the trestle were lower better “ results might be obtained but with the new trestle only “ eight feet above the surface of the ground and the piles “ driven to the rock similar failures followed.

“ When the difficulties on the east trestle developed an investigation by boring and test pit was made to determine the “ character of the material overlying the rock. It was found “ to be for the greater part an unctuous blue clay without grit “ possessing but little supporting power, instead of the stiff “ clay as indicated on the existing profile.

“ The investigation clearly demonstrated that *the construction of a dam which would remain after the lake is filled can* “ *be accomplished only by the removal of all the materials* “ *overlying the rock.* * * * Investigation of the foundations of the Sosa San Juan dam showed that the material is “ the same: the difficulties to be encountered will be greater “ because of the river.”

Various plans were submitted by Colonel Goethals in view of the impossibility of building, as it was projected, the dam planned by the minority of the Consulting Board and recommended a second time by a commission formed of two members of that minority and Mr. Freeman.

We have now seen that in four different occasions the opinions expressed by the minority of the Consulting Board have been controverted by facts. 1st: The estimates of the cost of the plan proposed is fixed to-day at more than twice the amount originally fixed, 2nd: Vessels both military and commercial, are now building which could not enter the locks, which three years ago seemed to the Board large enough to satisfy all future needs, except those to come at the end of the present century. 3rd: The cost of transforming rock into dredgable matter was fixed three years ago at a price which one and a half years later was shown to be eleven times too great in two instances and eighteen times too great in the third one. 4th. One of the two great dams to be erected, the one considered to be the most easy of execution and the most certain of stability, was found impossible at the place chosen and by the method recommended.

These manifest and undeniable errors of judgment on the four essential points examined should induce, a very careful revision of the opinions expressed on the fifth essential point: on the Gatun dam.

If an error similar to the four others already demonstrated occurs a catastrophe without precedent in history will follow. The result of ten years of arduous work, the result of an expense of four hundred million dollars spent by this government and of two hundred and fifty million dollars spent by the French share and bondholders of the Old Panama Company will be anihilated in a quarter of an hour without counting the probable destruction of the town of Colon and the possible annihilation of a whole fleet of men of war which will be stranded and imprisoned for years if the Gatun dam collapses during its stay in the Gatun Lake.

Cassandra had received from the gods the privilege of seeing in advance the calamities which menaced humanity but they had refused her the privilege of being listened to.

The part of a Cassandra is a disagreeable one and the victorious "I told you so" is a very poor compensation to the years of suspicion and ill-will which must be accepted before.

But I have received, I can assure you, no privilege from any god whatever, and if I say that this catastrophe is bound to come, it is simply the result of the rational method of induction which Bacon gave to the world and which has transformed humanity.

There are already facts enough to obtain truth by induction from them.

The two first facts are those I already spoke of. (A) the doubt cast, by Godin de L'epinay in 1879 on the possibility of its construction, that is by the man himself who conceived it and at the very moment he made his conception public. (B) the spontaneous statement I wrote to Mr. Noble in 1904 about the lack of foundations at this place. These testimonies were unbiased by any sentiments of bad or good will towards a project which was only to be formulated later in 1905. Though they are expressions of opinion, they may be retained as facts because both were the result of knowledge acquired from a series of experimental facts belonging to the Panama Isthmus proper.

We come now to the facts relating to the Gatun dam proper.

At the beginning of the second week of December last I read in a New York paper of November 26th, which had just arrived in Paris, the following cablegram of Colonel Goethals about a slide having occurred in the stone embankment which was to form the retaining wall of the earth of the Gatun dam. It read :

" Reported injury consists of slip in rock pile intended to " form south toe of Gatun dam and has no effect on body of struc- " ture which is not yet in place. Part of rock pile about 200 " feet in length crossing old French canal has been slipping " northward from time to time and slipped again on Friday, " (November 20th) due to excessive rains lowering crest " of pile about 20 feet. Slip of this kind not new, occurring " frequently all along the line. Present slip of no consequence and of character to be anticipated in such work."

This reassuring telegram did not reassure me. I knew of what the bottom of the French canal consisted. I did not hesitate to think that the accident was a providential lesson of nature showing in advance what was bound to be the fate of the Gatun dam at the end. I could read, though evidently the writer had not meant it, in the very telegram of of Colonel Goethals the real prophecy of what will take place later on: "Slips of this kind to be anticipated in such work."

Yes indeed, they are and it is precisely the reason why a dam of earth under this constant menace is so dangerous, so sure to succumb, so sure to annihilate the object of this magnificent enterprise, the ambition of our age.

What would be the result of a similar settling of the dam if it occurred when the dam is built? As you know, the normal levels of the waters are to be 85 feet above the sea level. It is admitted that the level in great floods will rise to 87 feet, and in droughts will be only 82 feet.

The crest of the dam was fixed originally at 135 feet leaving a margin of safety of 48 feet above the maximum level.

After the return of the Board of Engineers who accompanied the President-Elect to the Isthmus it has been *announced that they found the dam unnecessarily high and strong* and that the crest would be accordingly lowered 20 feet. This will reduce the proposed margin of safety to 28 feet.

Now, if the embankment of stone sixty feet high has lost through the slip of the 20th of November last twenty feet of its height, say one-third; the dam itself, 115 feet high, would lose under similar circumstances 35 feet. It would be reduced to an altitude of 80 feet above the sea, say seven feet below the maximum level of the water, five feet below the normal level and two feet below the minimum level. In a few minutes the dam would have disappeared.

Is the eventuality impossible to conceive? By no means.

It is on the contrary in the logical order of things if you examine the causes of the slip of the rock embankment.

The cause was the softness of the blue clay on which it was seated, its incapacity of supporting a load of any consequence.

The load resulting from the superimposed rock embankment was relatively slight compared to what it will have to stand when the dam will be established.

A rock embankment forms a sort of homogeneous and solidarized mass owing to the friction of one element on another. This insures a relatively equal repartition of the total weight on the base.

As the rock embankment is narrow at the top and wide at the base, the pressure per unit of surface on the natural ground will be about half what it would be if it consisted of a mass having the same base with vertical sides. On the other hand, in a stone embankment about one-half of the mass only is rock, the other half is formed by the hollow spaces, between the pieces of rock. On the other side a mass sixty feet high weighs about half what it would if 115 feet high, all other conditions being equal.

For these different reasons the pressure of the central mass of the dam on the ground will be about eight times greater than the pressure exerted by the rock toe and which caused the loss of one-third of its height.

It is therefore by no means inconceivable that under a pressure about eight times greater, the soft clay will slide away from under the dam much more than it did during what may be called the experimental slip of the rock toe.

This logical induction from the slip of the 20th of November is based on the assumption that it resulted from the lack of supporting power of the blue clay. You have a right to demand a demonstration of that assumption because if it is due to another cause the argument is erroneous and misleading.

After the New York Herald published on the 12th of December the statement I had made on the previous day about the certainty of the impending destruction of the Gatun dam, the answer was given out in the public press apparently from responsible sources that the slip *was expected and even desired.* It was explained that the cause of it was the light silt deposited upon the bottom of the old French canal. If it had been so the rock embankment would *have slipped upon the bottom of the canal and not through the bottom into the ground below.* This explanation would have acquitted the soft clay of any responsibility in the accident.

To support this hypothesis was the statement inserted in page 11 of the Annual Report of the Isthmian Canal Commission and signed by Colonel Goethals August 25th, 1908. Speaking of the soundings through the ground below the Gatun dam it said: "The material encountered is of such nature as to be " amply strong for supporting the proposed structure."

But Colonel Goethals is an officer and a gentleman and he is not capable of modifying the facts even if they controvert his opinion. In the answer which he was requested to make to me and which was published on the 10th of January last he said:

" The rock of the upstream toe has sunk about twenty feet " in height and 200 feet in length where it crosses the canal. " *In sinking it has squeezed out and pushed up the clay underneath.*"

This frank and open statement of fact shows that the rock pile has really sunk through the bottom of the canal into the soft clay. It acquits the silt and brings all the responsibility on the lack of supporting power of the clay.

If you remember what I extracted a little while ago from

Colonel Goethals' report about the impossibilities described at the La Boca dam you will see that the description he gives of the accident of the rock toe entirely resembles what he said about the La Boca dam. The two accidents were to be identical because the causes are identical at the two extremities of the canal.

But Colonel Goethals in his answer to me acknowledges also the presence of the blue clay and its lack of supporting power, thereby entirely withdrawing its assertion of August 25th, 1908, about the strength of the material below the dam. He says:

"The stratum of blue clay which Mr. Bunau-Varilla men-
" tions as a danger at Gatun exists chiefly into deep gorges
" in the rock which are crossed at about right angles by the
" axis of the dams and, where crossed, are about 1900 feet and
" 950 feet wide respectively at sea level. * * * It is im-
" permeable to water and *requires only to be kept in place to*
" *form a reliable foundation* for an earth dam of suitable cross
" section."

Colonel Goethals explains how, by extending the foot of the dam he hopes to counterbalance the tendency of the clay to escape from under the dam.

Now, Gentlemen, it is a matter of common sense. Is this any more admissible? Can the meaning of the words be changed? What is a foundation: It is a mass of ground on which a structure is to be erected. What part has it to play? Only one part, that is to keep the structure in place. Is this not the obvious and explicit condemnation of a given work when the chief engineer declares that the structure must be so devised as to keep the foundations in place? Does this not appear as a reversal of all the elementary notions of gravity and of natural forces? But a castle in the air could be projected on such a principle.

It would be possible and stable if we could keep the air in place by lateral wings of the castle.

No, the air will escape from under the wings as the soft clay will escape from under the body of the Gatun dam and from under its accessories, because it is a fluid matter like the air, though at the extreme limit of fluidity.

You may retard its movements, but they will take place at a given moment and at that moment the Gatun dam will have lived.

If we wish the connection between the oceans to be established we must not, as the majority of the Consulting Board said three years ago, indulge in dangerous experiments.

But now we have gone farther than that, the facts have shown the practical impossibility of the earth dams and we are driven into the land of imaginary engineering.

The Gatun dam will be destroyed by the subsidence below the level of the water of its crest which is 374 feet thick at that level. Its huge thickness of one half mile at the base will not protect it.

But there is another mode of death to which it is exposed, even if the movements of the clay below would not bring its crest below the level of the lake.

You have often seen while walking in the country these walls fissured and cracked. When you see that it is due to the fact that a part of the wall is seated on firm ground while the other is seated on soft ground. They do not settle together and an unavoidable opening ensues.

Now you have seen, by what Colonel Goethal says, that the blue clay existed chiefly in two places respectively, 1900 and 950 feet wide. The total length of the dam is 7700 feet. These figures show that at four different places at least there will be a sudden change in the resistance of the subground. At these four places crevices will be opened through the body of the dam through which the water will flow. The opening through an earth dam need not be great to entail the immediate destruction. A fissure of a fraction of an inch suffices, when there is behind that fissure a lake of 170 square miles surface and a head of 85 feet of water, that is to say, a pressure of about 34 pounds to the square inch.

Now, gentlemen, I brought before you the facts which demonstrate that the Gatun dam cannot and will not stand. This is the truth to which the induction from facts leads, I think.

But I have not come here as a prophet of evil to persuade that the way is closed and that we must abandon the hope of uniting the oceans.

On the contrary what I wish to say is that the solution of this great mystery of nature is at our disposition, and that we can obtain for less expenditure than remains to be spent on the lock canal with a dam at Gatun the free open junction between the oceans which I called the "Straits of Panama."

THE DIFFERENCE BETWEEN THE SO-CALLED SEA LEVEL CANAL AND THE SO-CALLED STRAITS OF PANAMA.

The word "sea level canal" describes the canal which Mr. de Lesseps started to build in 1881 and which was at that time thought to be the extreme limit of human possibility, if not beyond.

It was not then what humanity had dreamed of, what Mr. de Lesseps had dreamed of, but it was the next best thing.

What had been the dream of the centuries was the wide open communication between the oceans, free from any works of art.

The sea level canal of Mr. de Lesseps was a narrow canal just sufficient for one ship to pass, 72 feet wide at the bottom, 30 feet deep, open on the Atlantic Ocean but closed on the Pacific Ocean by tide locks. Why? Because though the two oceans have the same average mean level; one, the Atlantic, has no tides at Colon and the other, the Pacific, had tides 10 feet above and 10 feet below mean level. As the canal is in a very wet country it will have to carry to the sea the water of some rivers and it was not found possible to admit the combined currents due to the fresh waters and those due to the tides without troubling navigation.

To remove all these objections it is necessary to give 500 feet width at the bottom, 600 feet at the average water level and 45 feet at the lowest stages of the tides.

Such a canal was absolutely beyond the limits of possibility twenty-five years ago because of the enormous excavation it entails, six hundred millions cubic yards, and because of the impossibility of excavating then otherwise than by steam-shovels and trains.

In September 1905 at the outset of the studies of the International Consulting Board, I developed before this Board the methods by which this magnificent scheme may be said to have passed from the land of the imagination to that of the realization.

The Consulting Board refused to admit the demonstration resulting from the new methods of works and the most recent conquests of engineering. It remained faithful to the old principles of excavation, the excavation by steam shovels and the transportation by trains of the spoils to the dumps. The Consulting Board refused to admit that engineering had progressed since 1879.

The same causes producing the same results, the conclusions reached in 1906 were exactly those reached in 1879. The majority of the International Consulting Board adopted like that of the International Congress of 1879 the so-called narrow, tide-locked sea level canal and the minority preferred, as in 1879, the Godin de Lepinay's lake, dam and lock plan now in course of execution.

In the respective periods both majority and minority had thought of only one system of excavation, the excavation in the dry.

The International Congress was right in doing so in 1879 but the International Board was wrong in doing so in 1906, because in the meanwhile great progress had been made and a new factor entered into the play : The wet system.

The wet system of excavation, the excavation by floating dredges and the transportation of the spoils by barges to the dumps, is the system which made the Suez Canal possible.

Without it Mr. de Lesseps would have failed. He did not adopt it voluntarily, because his advisers, like the advisers of your government, actually were against it.

But one day the Khedive of Egypt, who was giving the compulsory labor to the Suez Canal Company, was forced by Lord Palmerston to suspend this practice. Lord Palmerston was a fierce opponent of the Suez Canal, he called it at the tribune of the British Parliament an enterprise of swindlers, and the suppression of the compulsory Egyptian labor was thought by him to be a death blow to the enterprise. It proved in fact what saved it.

Being without other resource the scientific advisors of Mr. de Lesseps could not oppose seriously Mr. Lavalley, an engineer of genius, then young and little known who said to Mr. de Lesseps : " Thank God, you have no more labor and at last you are going to be able to dig the canal ! " " How ? " said Mr. de Lesseps surprised ? " By dredges for excavating " and barges for transporting."

Mr. de Lesseps accepted the proposition because his advisors were silenced by the absolute want of labor. Seven years later the canal was thrown open to the world.

What the dredge has done for the Suez Canal it has to do for the Panama Canal, and it will do it. In 1879 the dredge of Suez could not dig Panama because it had not been taught to bite rock. I made in 1885 the first step in that direction and it now does it admirably.

To think of making the sea level canal without giving it all its qualities, its entire independence from all artificial structure, such as locks and dams, is a great error.

The objections against the so-called sea level canal: its high cost, the undetermined period of its construction, the presence of a tide lock on the Pacific, and of a steel concrete dam on the Chagres before it enters the canal are all perfectly founded. They all apply to the narrow, tide locked, sea level canal they do not apply to the Straits of Panama.

They apply really to the method of construction and to the consequences it has on the type of the canal.

If you change the method of construction, if you attack by dredging, you will establish first a lock canal, but it will have no huge locks, no earth dam at Gatun. The steel concrete dam will be established at Gamboa less for the purpose of controlling the Chagres than for that of creating an enormous lake which will receive all the spoils, and give by its falls the energy for the works.

The dredges will work on the summit level and widen it to its full extension; then they will dig it and, while they will lower the bottom, water will also be lowered until the lateral levels are reached. The new summit level will be treated in the same way, thus all the successive levels will be eliminated and the sea level reached.

All these spoils will be brought by barges into the lake formed outside the canal, in the high valley of the Chagres, above the point where the river enters the canal line.

It will not only form the easiest and cheapest way of disposing of the spoils; for several miles the valley will be filled and a new and higher bed will be thus formed for the Chagres.

At the end of the digging the Gamboa dam will have ceased to exist as a dam. It will form the extremity of the upper new valley, but the water will not any any more press upon it. The dam will have to play but the insignificant part of a retaining wall and nothing more.

It will have ceased to exist as an essential organ of the canal, earthquakes may destroy it. It will have no effect on the canal.

In this system the minimum will be left to the action of man and the maximum to the action of nature.

The electricity generated by the falls of the lake will put in action the rock breakers, the floating dredges, the scows. The water in the small barge locks, will raise the scows from the level of the summit to that of the lake, and the depths of the lake will absorb the material of the Straits. Thus the Chagres once harnessed will offer freely by its waters the way for the excavating and transporting instruments, by its falls the energy to animate everything, and by its upper valley the dump to receive the spoils.

To establish the first work lock canal four years are necessary, and to dig the Straits ten years more.

If you establish locks large enough to pass the largest men of war in existence, including the 26,000 tons warships just begun, 95% of the commercial vessels will be able to transit alongside the work during the excavation. The cost of dredging the Straits will be one hundred million dollars and the cost of the first phase, if constructed for temporary transit of ships, with locks 575 feet long and 110 feet wide would be also one hundred million dollars.

The total cost of the ideal solution, of the first class solution would be now $200,000,000 ; that is about what remains to be spent on the lake, dam and lock solution, on that solution which is not only unstable and condemned to a historical catastrophe, but which, even carried on, would be obsolete before its inauguration owing to the constant increase of size of ships whether commercial or military.

It is the solution by which the progress of science allows us to-day to fulfill the order send by Charles V to Hernando Cortez in 1523 from Valladolid to go and search for the "Secret of the Isthmus." The "Secret of the Isthmus" is in the rational utilization of the Chagres.

I have tried to bring before you only facts and figures. I hope they have been eloquent enough to make you forget the insufficiencies of my English.

IMPORTANT COMPLEMENTARY POINTS ABOUT THE "LOCK CANAL WITH A DAM AT GATUN," THE "SEA LEVEL CANAL" AND THE "STRAITS OF PANAMA."

NOTE OF THE AUTHOR.

Though I proposed to speak of the following facts in the course of my address before the Commercial Club of Boston, I feared to ask too much of the patience of my hearers, and I was led to limit my remarks to the principal points and to give the lecture which has been inserted in the Congressional Record.

However, I feel myself at liberty to add them in this pamphlet as a complement to the address. They must be considered as a part of it, though they were not expressed by word of mouth.

Also, I have added as a third chapter what might be called the corroborative evidence against the "lock canal with a dam at Gatun." It is formed by the extracts from the testimonies of the engineer officers of the Canal before the Congressional Committee of Interstate and Foreign Commerce, in January, 1909, at Ancon—Canal Zone.

A LOCK CANAL MAY BE SAFELY ESTABLISHED ON THE ISTHMUS, BUT WITHOUT A DAM AT GATUN.

Does what I said mean that a lock canal is impossible of construction on the Isthmus?

Not at all!

The unsafe part of the actual lock plan is the dam at Gatun.

Why was it adopted? Will you ask! Here is the answer:

Any lock canal with a summit level must have a provision of water. This provision of water must be formed by damming the Chagres somewhere. There are four points where it can be proposed to dam the Chagres.

One at the lowest possible point of the valley, at Gatun on the canal line.

Another one nine miles higher up, at Bohio on the canal line also.

Another one just above the point where the Chagres enters the canal line, at Gamboa.

Another one 10 miles above the point where the Chagres enters the canal line, at Alhajuela.

The higher up you choose the point where the course of the Chagres is to be stopped by a dam and a lake formed behind the dam, the less water you collect in your reservoir because all the tributaries of the Chagres below the dam will flow to the sea and will not be stored in the lake.

This is the inconvenience of the location of the dams higher in the valley: the higher you go the less water you store.

The advantage on the other side is that the higher you go the higher also you meet the bed rock and the better are your foundations.

At Gatun the bed rock is at 265 feet below sea level.

At Bohio 9 miles higher up the valley it is 157 feet below sea level. At Gamboa 12 miles above Bohio it is at sea level, that is about 40 feet below the bed of the Chagres. At Alhajuela

10 miles above Gamboa the bed rock forms the bed itself of the river.

These inverse qualities of the various locations explain easily how in the different projects of a lock canal the site of the dam has been changed from one location to the other.

The engineers who do not care for the amount of traffic which a lock canal can serve and who look only for the easiness of construction of a perfect dam will choose the location of Alhajuela. There a masonry dam, the only kind of structure admissible for a high dam, is easy to erect.

It was the project of the new Panama Canal Company, but the easiness of the erection of a dam was in fact outweighed by the difficulty and danger of constructing a connection between the Alhajuela lake and the summit level which it has to feed.

The Gamboa location is perfect also from the point of view of safety. A masonry dam can be easily erected there with the assurance of complete stability because precise calculations of stability can be made for a masonry dam. On the other hand the Gamboa dam is in immediate contact with the summit level, and there is no difficulty nor danger in establishing the water communication between the lake and the summit level. All the conditions regarding stability are obtained there. But the amount of water received in the reservoir is only two-thirds of what would result from a dam at Bohio, while a dam at Bohio would also collect only two-thirds of the water which would be collected by a dam at Gatun. Therefore the limits of the capacity of traffic would be in round figures 26,000,000 tons with a dam at Gamboa, 40,000,000 tons with a dam at Bohio and 60,000,000 tons with a dam at Gatun.

It would be therefore impossible to construct a lock canal with a dam at Gamboa with any idea of perpetuity.

The Isthmian Canal Commission in 1901 was led to select the Bohio location for a dam because there the conditions were sufficiently good to ensure the establishment of a satisfacfory structure, though of a quality much inferior to that resulting from the selection of Gamboa as the location for the dam, and at the same time the mass of traffic which could be served was sufficiently great (40,000,000 tons annually).

However the Bohio location could not admit the perfect type for a dam, the masonry dam, on account of the depth of bedrock. The Commission was forced to admit an inferior type of structure, the earth dam with a masonry core.

But when in 1905 the question of the type of the Canal came again to the front, the constant increase in the size of ships obliged the defenders of the perpetual lock type idea to recognize that with a dam at Bohio a lock canal could not be called perpetual on account of the increase of the consumption of water due to the necessity of increasing the dimensions of locks.

The intense desire of increasing to its utmost limit the storage of water was the only cause of the selection of the Gatun location for the dam. But there only an embankment of earth could be thought of as a dam and therefore the poorest kind of structure had to be resorted to. Instead of carefully observing the limitations traced by nature, instead of drawing a project inspired by these limitations, the contrary was made. It was nature which they tried to submit to the needs of a preconceived idea, the construction of a perpetual lock canal.

We can see now the results.

Nature cannot be forced to fulfill the ambitions of man outside of the limits which Science has to recognize and to fix.

When this is tried Nature reacts and man is as powerless against its reactions as the Lilliputians were when they tried to chain Gulliver.

The dam at Gatun will certainly succumb under the combined influences of the pressure of the lake and of the lubricating influence of the water on the soft, plastic, slippery clay upon which the huge embankment will be seated. This is the thing which is now demonstrated.

THE ESCAPE OF THE WATER OF THE LAKE THROUGH THE FISSURES OF THE CLAYISH SANDSTONE OF THE HILLS AT GATUN ANOTHER GREAT DANGER. WILL THE BELT OF HILLS ENCLOSING THE LOWER PART OF THE GATUN LAKE PROVE TO BE A HUGE SIEVE ?

But there is another fact which is of the greatest moment.

The huge locks will be erected on a kind of rock which is at the very limit between rock and earth. It is a mass of sand agglomerated by a green clay. Though strong enough, with a very narrow margin of safety, to stand the pressure of the walls of the locks, it is an unreliable ground. The insufficient resistance it offered to the shocks of the frequent light earthquakes of the isthmus have caused the interior compressions which resulted therefrom to open permanent fissurations. This is a very dangerous character, because the clay which unites the particles of sand is very liable to be carried away under a constant stream of water and slight fissures will be soon transformed into great ones.

This danger is sufficiently established to have caused Colonel Goethals to provide for a deep curtain of masonry in front and below the foundations of the locks in order to prevent this underground flow to pass below these foundations and to eat them up gradually.

How much will the curtains of masonry, in front of the locks and below the level of its foundations, keep the water from flowing in the fissurated ground underneath, is a matter of pure speculation. It would be necessary for absolute safety to bring the masonary curtain below the lowest fissures. Who knows their level ?

But if this flow is sufficiently established to oblige the engineers to resort to such expedients near the locks, what may be thought of all the surrounding hills which will have to keep the water in place outside of the dam proper ? Will they fulfill their part faithfully and prevent the water from escaping through their fissurated mass? Will they not prove to be a huge sieve?

This is not a danger which is actually demonstrated, but the provision of the masonry curtain in the locks demonstrates that the gravest suspicions may be raised against the lateral hills.

They seem to be as little able to keep the water in place as it is demonstrated that the subsoil below the dam is unable to keep the structure in place.

The Fissured Soft Rock with Soft Tufa Below an Exceedingly Dangerous Foundation for the Concrete Dam Which will be Erected in Gatun Hill for the Spillway.

A masonry dam is a perfectly safe structure and can be calculated with absolute precision provided it is resting on an extremely solid foundation. It is the most dangerous of structures if the rock below is not above any suspicion.

In the middle of the Gatun dam which will be made of earth, is a little hill where the outlet of the lake will take place through convenient regulating apparatus.

In order to erect the earth dam the river, during the depositing of the earth, will be deviated through Gatun Hill. The hill will be excavated down to 8 feet above sea level. After the earth dam is completed a masonry dam will be erected there and close the valley.

It will be resting on this soft argillaceous sandstone, where so many fissures have been discovered. The strength of such a sandstone is, compared to that of the red sandstone on which the masonry dam of Bouzey (France) was erected like lead compared to steel. The Bouzey dam was erected with the greatest precautions by the best engineers of France. Mr. Picquart, actually Minister of Marine and former commissioner general of the Exposition of 1900, was one of them.

It gave way because the red sandstone was not a sufficiently good foundation for a masonry dam. Its destruction entailed considerable loss of life.

The Habra dam also a masonry dam in Algeria met his fate in the same way on account of imperfect foundation.

Both structures had been considered for 20 or 30 years as perfect.

After such examples it seems a challenge to the laws of nature to build a masonry dam on the soft deliquescent argillaceous sandstone of Gatun Hill, when it is known that soft material like tufa underlies it, which a current of water will disintegrate immediately.

True it is to say that the engineers will endeavor to place a curtain of concrete in front of and below the foundation of the dam in order to cut the flow of water through the fissures which exist in the soft argillaceous sandstone. But it has been recognized that these fissures communicated between each other to a distance of 2,000 feet measured horizontally.

There is no reason to think that such extensive ramifications of fissures are limited to the surface; they must extend in the depth of the subsoil. The apron of concrete will simply oblige the water to go below the apron before flowing below the dam. That it will flow below the dam there is no doubt; that below the dam the argillaceous sandstone is underlied by a very loose tufa there is no doubt; that the argillaceous sandstone itself disintegrates in a current of water there is also no doubt. For anybody familiar with the history of masonry dams there is no doubt that the dam in Gatun Island will be undermined and ruined very quickly.

What Canal May be Called Perpetual? The Straits! Opinion of Sir John Wolfe Barry About the Method of Excavation Proposed: The Wet System.

This is another obvious and necessary consequence of the fact that the Gatun location has been chosen not account of sterling qualities which a dam imperatively requires, but on account of the ambitious desire of giving to a certain type of canal; the lock canal type, a quality which nature prohibits to give him on the Isthmus—Perpetuity.

The only solution which may legitimately be called perpetual is the solution which is independent of the size of ships. It therefore must have no locks.

The only solution which may legitimately be called perpetual is the solution which is independent of any storage of water. It therefore must be at sea level.

The only solution which may legitimately be called perpetual is the solution which is independent of any artificial work because any artificial work such as the most perfect dam, the masonry dam, may be wrecked by an explosion of dynamite or by a very severe earthquake. It must therefore be free from any artificial dam.

The only solution which meets all the requirements of perpetuity and at the same time those of perfection is the wide, open, free junction between the oceans, 600 feet wide at average water level, 45 feet deep at the lowest tides, 500 feet wide at the bottom.

It is the project which I submitted, and which I characterized by the name of "Straits of Panama", to the consulting Board in 1905. It is this complete solution which Mr. Alfred Noble, the great engineer who has been the commanding figure in the camp of the Lock Canal party, declared recently to be the perfect and the ideal solution at the annual banquet of the alumni of the Stevens Institute. But he added that the cost and the time of its construction rendered it prohibitive.

I have answered in the "New York Herald" of Sunday, February 21, last, quoting the remarks of the greatest English expert living, Sir John Wolfe Barry. It is not unnecessary to reproduce the "Herald's" article.

Extract from the New York Herald of February 21, 1909.

M. BUNAU-VARILLA ANSWERS A "LOCK CANAL" ARGUMENT

SAYS ALFRED NOBLE'S SPEECH ADMITS SEA LEVEL PLAN IS ONLY SOLUTION OF PROBLEM—QUOTES SIR JOHN WOLFE BARRY'S APPROVAL OF HIS IDEA FOR "PANAMA STRAIT."

ASKS "IS 'GO AHEAD!' NO MORE AMERICAN?"

M. Philippe Bunau-Varilla, the eminent French engineer, whose views regarding the isthmian canal have aroused world-wide interest, made timely comment yesterday on some significant admissions made on the previous evening by Mr. Alfred Noble, a leading American engineer, concerning the Panama Canal.

At the annual dinner of the Stevens Institute of Technology, held in the Hotel Astor, Mr. Noble, who is chief engineer of the Pennsylvania Railroad and was successively a member of the Nicaragua Canal Commission, then of the Isthmian Canal Commission which had to decide between Nicaragua and Panama, and finally a minority member of the International Consulting Board, the majority of which voted for a sea level canal, spoke of M. Bunau-Varilla's plan in the following terms :—

"I realize fully that in this vicinity a preference for a sea level canal in Panama is natural. Such a broad channel at sea level as the one advocated by the eloquent and ingenious M. Bunau-Varilla and by him appropriately designed as the 'Strait of Panama,' would afford a quicker and safer navigation than any possible lock or summit level canal. But on account of its enormous cost and the prolonged period required for its completion the 'Strait of Panama' must long remain a work of the imagination rather than of practical realization."

"DIVIDES FACES OF SUBJECT."

M. Bunau-Varilla was asked yesterday by a reporter for the Herald if he had anything to say on Mr. Noble's statement. He answered :—

"Mr. Noble is one of the greatest engineers living. Whatever he says must be listened to with respectful attention. In a few words he has divided admirably the two faces of the subject.

"The 'Straits of Panama,' according to the opinion of this commanding figure among the sponsors of the lock plan, is the only complete and perfect solution of the Panama problem, the only one which will insure safety and rapidity of navigation more than any other plan.

"This statement is of capital importance, because it is a statement of general principles. It eliminates the idle arguments of those defenders of the lock plan who tried to persuade the world that it possessed advantages over the free, natural, open highway between the oceans. It was as idle to say that as for a surgeon to maintain that a wooden leg is preferable to a natural one. But, however many persons were brought to believe it, Mr. Noble though having signed and still defending the actual lock plan, proclaims it an inferior solution.

"Mr. Noble's statement might be written as follows:—'Though the 'Straits of Panama' constitute the most perfect solution, we had to be satisfied with another of inferior order affording less security, because the best solution was above our resources and would take too much time.'

"Is 'Go Ahead!' No More American?"

"America has been distinguished as the land of unlimited possibilities. Its discovery was due to one of those splendid efforts by which the human mind has successively broken through the limits within which timidity and routine incarcerated human action. I have been brought up in the admiration of this energetic race, which, with the hand on the plough and the revolver at the belt, conquered a continent to humanity, which connected the two great oceans of the planet with a continuous line of iron and the two great continents of the planet with a continuous line of copper. How can its greatest engineers to-day speak as the bishops of Salamanca spoke to Columbus. 'What you propose to do is beyond the limits of possibility'? Is 'Go ahead!' no more American?

"Even if the complete solution of the Panama problem was really beyond the reasonable limits of time and expense, it should be kept conspicuously in view. It should be shown as the final goal, and the genius of the human race should be invited to forge the tools with which it can be reached. This is how the transcontinental road was built; this is how the transoceanic cable was laid; this is how the Suez Canal was dug.

"But we have not to look forward for the tools which can open the 'Straits of Panama.' The 'Straits of Panama' would be indeed beyond the limits of actual human possibility if we tried to dig them by means of steam shovels and transport the spoils by trains to the dumps. Even the so-called sea level canal, with its width only one-third that of the 'Straits' and with its reduced depth, with its tide locks established on the Pacific side in order to prevent the tidal currents from entering a narrow canal and disturbing navigation, would require from thirteen to twenty years to dig by the method of dry excavation. The 'Straits,' therefore, would take by the same method forty to sixty years.

"But if you change the method, if you dig and transport by instruments floated on water, what is an impossibility in the dry system becomes not only practicable but easy in the wet. The realization of the first class solution—the 'Straits of Panama'—will not only cost much less than the second class solution—the tide locked sea level canal—but it will also cost less than the third class solution—the lock and lake solution, with its terrible sword of Damocles hanging over it—the Gatun dam.

"To this I know Mr. Noble will answer, 'Your proposition would be all right if it were not for the rock which will be found in the excavation and which a dredge cannot bite.' This might have been said twenty-six years ago, but it can no longer be said now. Enormous advances have been made in this branch of engineering. Mr. Noble acknowledged it when, as a member of the Isthmian Canal Commission, he signed in 1901 a list of standard prices where the extraction of rock under water was set at $4.75 a cubic yard, and when five years later he signed as a member of the International Board of Consulting Engineers another list of standard prices, where the same work was fixed at $2.50 and where the dredging of loose material, including transportation and dumping, was fixed at fifteen cents a cubic yard.

" A CONCESSION TO PROGRESS."

" This was a great concession to progress, but was it a sufficient one? No. The art of extracting rock under water consists now in breaking the rock, in transforming it into loose material. The two prices above named show that this operation of loosening the rock and making it as dredgable as sand was calculated by the consulting board at $2.35 a cubic yard. What does it cost in reality?

" This has been shown by reports brought before an association of engineers which is second to none—the Institution of Civil Engineers in London—at the conference of June, 1907. The official reports from the works at the Suez Canal and at the harbor of Blythe have shown that the cost in these two instances was about twenty cents a cubic yard. The verbal statements of the chief engineer of the Manchester Ship Canal also showed at the conference that the cost had been there only twelve and a half cents a cubic yard. Therefore the standard cost admitted in 1906 by the Consulting Board for loosening the rock was proved in 1907 to have been respectively ten times and eighteen times greater than reality demonstrated.

" NEED NOT BE DEFENDED."

" This is the real weight of the arguments under which, as General Edwards said recently, was crushed the project of the 'Straits of Panama' by the International Consulting Board in 1906. It needs for its defense neither eloquence nor ingenuity, because it is the expression of the dream of the centuries and because the progress of industry and of science has already forged the tools which to-day make the 'Straits of Panama' the most practical and the most economical of all the plans from the point of view of construction.

" It need not be defended. It defends itself. But a man who exposes his own ideas may always be accused of looking at them through rose colored glasses. Hear the voice of a perfectly independent judge, of a man who is certainly the greatest living English engineer, the voice of Sir John Wolfe Barry, who made the latest bridge in London—the Tower Bridge. He presided over a meeting of the Royal Society of Arts in London at which, in January 1907, I developed the conception of the 'Straits of Panama' and of the scientific methods by which they can be constructed. I extract from the journal of the society a part of the commentary he made after my lecture:—

" '*In principle one could not help being captivated by the idea that the work could be constructed and brought to a proper issue by the use of water as the carrying power for the machinery to do the excavation, and as the carrying power for the transport of the dredged material to its destination. One could not help being struck also with the great ingenuity by which a large receptive place could be made where the dredged material could be deposited at a level which was sufficiently convenient for the barges to reach.*'

" The broad principle commended itself to an engineer at once, that if it was possible to use the flotation power of water to bring the excavators to the place where the excavation had to be made, and if it was also possible to take the barges from the dredger to the place for which they were destined, it would solve some of the greatest difficulties in dealing with such a work in such a country. As the author said, instead of treating the great rainfall as an enemy he converted it into a friend and an ally, and if this plan could be carried out it seemed to him a most valuable suggestion.

"VERY WELL KNEW THE GREAT COST."

" 'His own experience went to corroborate these views entirely, because he very well knew the cost of excavating in water-logged strata when the excavation was made in the dry, where the rain caused innumerable slips of earthwork and occasioned the greatest difficulty in maintaining the roads. If these difficulties could be avoided an enormous amount of trouble would be done away with and *a price reached which would be far and away less than anything which could be contemplated for excavation in the dry.* He supposed one might almost say that the Suez Canal would have been impossible of construction if it had not been for the great improvement in the dredging plant which took place at that time, although in that instance the distances to which the earth had to be transported were comparatively short.

" 'Since that time the development of dredging plants had gone on by leaps and bounds and engineers were now able to use dredgers supported by water at the spot where the work had to be done—dredgers of a power and celerity of excavation never dreamed of in former years.'

" Speaking of the Suez Canal, as one of the former members of the International Technical Consultation Commission of the canal, Sir John Wolfe Barry said, further :—" '*It was at one time considered that the excavation of rock between the Bitter Lakes and Suez, for the purpose of deepening the canal to suit the modern requirements of ships, presented such a serious obstacle that the work was suspended for many years, although everybody knew it would have to be done. But that difficulty disappeared. The work was done without explosives, the traffic of the canal was not interrupted, and the price at which the excavation of the rock under water was done was given by Mr. Kellennec at one shilling a yard.*

" 'Mr. Hunter also stated that he excavated the rock in the Manchester Canal under water by the same Lobnitz process at nine pence a cubic yard, and these prices engineers must take as facts. *Taking these prices as true—and they must be so considered on the evidence of such eminent engineers—it did seem a very startling proposition that engineers should be contemplating at the present time such a very large price for the Panama Canal as ten shillings a cubic yard (2.50) for rock excavation.*

DANGER OF EARTHQUAKES.

" 'He (Sir John), therefore, thought every one would welcome the idea which the author had enunciated, that they need not be content with what one might call a canal, but might look forward to what had been better described as the 'Straits of Panama.'

" 'Another thing which struck him was that the recent sad experiences at Jamaica and in Valparaiso and in California seemed to indicate that a great work of international importance in such a locality as Central America and the Isthmus of Panama ought, if possible, to be so designed that what were called 'works of art' should be altogether avoided. A lock system canal in a volcanic neighborhood subject to earthquakes could not be contemplated with complacency, and when the enormous amount of money which was to be spent on the work was taken into consideration, it seemed to him as an outsider—because he was only an outsider in that particular matter—that anything in the nature of large masonry dams and locks closed with gates, which would be absolutely wrecked by comparatively light shocks of earthquake, should be avoided in such a magnificent enterprise.'

"Thus spoke the man who may be called the highest exponent of hydraulic engineering in England," added Mr. Bunau-Varilla. "It counterbalances the opinion expressed in a certain technical organ, which termed 'fantastic' the new method of digging the 'Straits of Panama.' I am only sorry it has found access to and was reproduced in the Canal Record, which, as you know, is published under the authority of the Isthmian Canal Commission.

THE METHOD OF DISCUSSION ADOPTED BY THE OPPONENTS TO THE "STRAITS OF PANAMA."

The absolute perfection of the "Straits of Panama" is obvious for any man. It covers so clearly all the requirements which must be fulfilled by an artificial waterway across the Central American Isthmus that its opponents, the sponsors of the perpetual lock canal with an earth dam at Gatun, the sponsors of the third class solution, as well as the sponsors of the narrow tide locked "sea level canal" with a steel concrete dam at Gamboa, the sponsors of the second class solution, cannot find an argument against it.

Their strategy simply consists in acknowledging its perfection but in dismissing it without any further discussion by calling it chimerical. They add for sustaining this contention that this project was examined and rejected by the majority and by the minority of the Consulting Board in 1906.

This being done by tacit and mutual consent of the sponsors of the lock plan and those of the sea level plan the questions asked from both about the "Straits of Punama" are answered as if such solution had never existed and a wilful confusion is thus made between this solution and the one called "sea level canal." The objections made against the "sea level" plan by the defenders of the "lock plan" are thus injected into the public mind as applying to the "Straits of Panama" plan. It is however obvious that the reproach of having tide locks, the reproach of having a high masonry dam, the reproach of consisting of a narrow and deep cut which may be closed by a slide do not in any degree apply to the "Straits of Panama" plan which is free from any locks, from any dam, and which provides for very wide waterway.

Another unfair method of discussion is that of comparing the dam at Gatun with its head of 85 feet with the dam at Gamboa with its head of 170 feet in the sea level plan, and to say that the second one will be more dangerous than the first on account of its greater head of water. It is a misleading argument which cannot be expressed by any engineer worthy of this title.

The danger for a dam is not the head of water it has to stand, it is the nature of the foundation upon which it is seated.

A dam having the level of the water 300 feet above its foundations like the Croton dam is a perfectly safe structure, if its masonry rests upon solid rock and if the masonry is made with the cement of required quality.

A dam of earth even with a head three times smaller is a highly perilous structure if it is resting, like that of Gatun, on a semi fluid clay without supporting power.

CORROBORATIVE EVIDENCE BEARING ON THE FACTS WHICH HAVE BEEN SIGNALLED IN THE BOSTON LECTURE AS ENTAILING THE GRAVEST DANGERS FOR THE SAFETY OF THE PANAMA CANAL.

This corroborative evidence may be obtained from the hearings before the Committee on Interstate and Foreign Commerce of the House of Representatives at the Hotel Tivoli, Ancon, Canal Zone, January 6 and 7, 1909.

The facts brought out in the hearings are precisely those which always since the actual lake, dam and lock plan was adopted in 1906 convinced me of its extreme instability, of the radical defects which should lead to abandon it at any cost and as early as possible.

The distinguished army engineers who testified before the Committee report these facts with their usual scientific straightforwardness.

It will certainly astonish the readers to see that in spite of these ominous facts they still adhere to the opinion that the actual plan can be carried out.

There is not the slightest doubt that if the facts actually demonstrated had been brought to light in 1906, there would not have been a group of engineers to recommend an interoceanic canal, the very existence of which had to depend—1st upon such suspicious and wholly unexperimented theories of equilibrium for the earth dam at Gatun; 2nd upon such deficient foundations for the locks and the masonry dam at Gatun island as that formed by argillaceous sandstone resting on this mixture of sand and volcanic ashes called tufa, when it is known that this ground is fissurated and that water flows through it; 3rd upon the unwarranted and suspicious assumption that the hills encircling the lake will be watertight, when it is demonstrated they are fissured by crevices and cannot but loose water in unknown quantities, when the existence of the lake must give to the water in these fissures a head of two atmospheres and a half, and force it to find new outlets very likely in the vicinity of the dam.

In all conceptions of the engineering mind reality brings forward supplementary difficulties which had not been seen at the outset. It is a natural and wholly justified tendency of those in charge of the execution not to effect a retreat in face of the first difficulty but to try to overcome it. But there is a limit to that sort of courage. And the limit exists when the risk for the work undertaken becomes so great as to be wholly inacceptable as in the present case.

But whose duty is it to proclaim that the limit has been passed? Whose duty is it to order the abandonment of the plan?

It is not wise to ask that from the authors of the project. Their mind is not free, it works under the load of a preconceived idea which destroys the elasticity of their judgment and debilitates their faculty of observation.

It is not wise either to ask that from the engineer officers to whom has been entrusted the honor of winning that great battle against nature. For them to say that the difficulties encountered are above the resources of practical engineering; for them to say that the actual project must be abandoned because there is no certainty even remote of the stability of its main structures except by a veritable miracle, it is like avowing a defeat and sounding the retreat. What the reason and wisdom of the engineer advises the brave heart of the officer refuses to express. This conflict between the two noble sides of the conscience of the engineer officer is more manifest than anywhere in Major Sibert's testimony of which abstracts are given hereafter. The facts he shows condemn the plan as a secure one, but when asked if he has lost confidence in the actual canal, he says: "I think it can be built." It recalls, though inversely, that struggle in Galileo's mind when, after withdrawing on his knees his own theories about the movement of the Earth before the Tribunal of Inquisition, he exclaims, when rising: "Nevertheless it moves."

The duty of sounding the necessary retreat is incumbent upon the supreme authority, which has before the world the responsibility of creating a stable, perfect junction between the oceans.

This is why it would have been so necessary for the American administration to send recently to the Isthmus a body of unprejudiced, free minded engineers to confront facts with opinions and report the conclusion.

Unfortunately this board of engineers which was originally to consist of six persons, but which was brought to seven at the last moment, was not composed either of men entirely free from any preconceived ideas or even of men in equal number and known as supporting adverse theories. Three members of the Board were known as intimately associated with the actual plan, two MM. Stearns and Randolph for having proposed and signed it in 1906, another Mr. Freeman for having approved it unqualifiedly as a member of the Board, which went to the Isthmus with Mr. Taft in 1907, and which was formed of himself and of two of the signers of the plan, MM. Noble and Stearns. The opinion of the Board of 1909, like that of the board of 1907, are therefore not independent expressions of opinion. The spirit of the minority of the consulting Board of 1906 must be considered as having been the predominating influence in 1909. The report of 1909 like that of 1907 are nothing but the two successive echoes of the report of 1906.

Let us now come to the facts as developed by the testimonies of the Isthmian Canal officers before the Congressional Committee.

THE YELLOW TUFA.

On the question on the yellow tufa which is found below the argillaceous sandstone in the foundations of the locks and in the foundations of the masonry dam on Gatun Island Major Harding answered as follows:

Mr. STEVENS: What is the yellow material of which you informed us?

Major HARDING: The yellow material seems to have been formed in part by a deposit of volcanic tufa, *a mixture of sand and volcanic ash.* It is a yellow, light material which is of volcanic origin. That material changes gradually from soft sandstone into argillaceous sandstone with tufa mixed. The change is so gradual that it is impossible to draw a line and say above this line is soft sandstone and below this line is argillaceous with tufa mixed.

Mr. STEVENS: What do you propose to do with this yellow, soft sandstone in the lock foundation?

Major HARDING: I propose to test all parts that are, in my judgment, at all doubtful to at least twice the load that is to come upon them. If the material thus tested settles appreciably I would propose that that material should undoubtedly be removed and the removal continued until material sufficiently strong to stand the test without any question is reached. The extent of this material, both vertical and horizontal, is a matter of judgment pure and simple, and the question of whether it should be removed locally, the soft parts being taken out, or a general removal of everything, including the good and the bad, down to a certain level, is also a question of judgment.

Mr. STEVENS: When you remove the tufa and doubtful material, what will you put in its place?

Major HARDING: Concrete.

Mr. STEVENS: Just as a dentist plugs a tooth?

Major HARDING: Yes, sir.

Mr. STEVENS: So you propose to go to that depth and find a foundation which you are sure will prove safe for the load that will be placed upon it?

Major HARDING: I do.

WHY THE HEIGHT OF GATUN DAM WAS REDUCED.

On the question of the reduction of the height of the Gatun dam Major Harding explains why it was proposed. Far from stating, as it was officially announced that the Board of

Engineers which went with President-elect Taft did, that the Gatun dam was unnecessarily high and strong, Major Harding says that the reduction of height is proposed to increase the stability of the dam in reducing the pressure on the soft clay upon which it will be seated.

Mr. Esch: I understand the original plan was to have the dam 135 feet high?

Major Harding: Yes, sir.

Mr. Esch: It is now contemplated to build it only 105 feet high?

Major Harding: There was a proposition to that effect, to which I subscribed—to reduce the height to 105 feet instead of 135 feet.

Mr. Esch: Would that diminution in height lessen the security of the structure?

Major Harding: *I think it may possibly increase the stability of the structure.*

Mr. Esch: Explain that, please.

Major Harding: The weight of the material that is going to form the dam has been measured, and it gives a pressure at the bottom of a ton to the square foot for every 20 feet in height; so, *if we lower the level of the crest of the dam 20 feet we take off a ton to the square foot of the base of the dam underlying the part that is taken off.* In other words, the pressure on the foundation of the dam will be a ton less per square foot than it is at the present time. The crest, 105 feet high, is 20 feet higher than the maximum level of the lake; it is 15 feet higher than the lock walls or lock gates; and it is higher than some of the natural hills that form the limits of the lake. The height of 20 feet above the lake is certainly ample to take care of any wave action that might occur. The horizontal dimensions of the dam, if the height is reduced 20 feet, would remain the same as they were before. The final 20 feet in the dam would cost more than the rest of it per unit, and I can conceive no useful effect of that excessive height, unless it be to provide a margin of safety to take care of any settlement that it may be anticipated will hereafter occur.

WHAT WILL BE BELOW THE FOUNDATION OF THE MASONRY DAM OF THE SPILLWAY.

On the question of primary importance of a perfect foundation for a masonry dam Major Sibert explains that the masonry dam at the spillway will be seated on argillaceous sandstone underlied by tufa described by Major Harding as a mixture of sand and volcanic ashes. He further states that the ground is fissurated.

These are conditions infinitely worse than those which caused the catastrophe of the dam at Bouzey (France) and that of the Habra dam in Algeria.

Mr. STEVENS: Did you find a good foundation for the walls of the spillway?

Major SIBERT: Yes, sir.

Mr. STEVENS: What is the formation?

Major SIBERT: Argillaceous sandstone.

Mr. STEVENS: And you did not find softer stone and tufa?

Major SIBERT: *The same material is there but lower down.* We did not have to go so deep for the foundation of these walls as in the locks.

Mr. STEVENS: What is the height of the miter sill of the spillway above sea level?

Major SIBERT: The miter sill applies to the locks only. The height of the foundation would be the point you are after. The spillway itself would not have been excavated to anything near the depth it is now had it not been necessary to use it as a diversion channel for the Chagres while we were building the dam between the hills; but the depth of that excavation was fixed by the probable height the Chagres River would attain during floods, and we dug it down. It is now 8 feet above sea level. We figure that when the Chagres goes through there, it will not attain such a height as to interfere with our work, and we will ultimately build a concrete dam across founded on this 8-foot elevation. The top of the concrete will be about 16 feet below the lake level, and on the top of the concrete dam we purpose placing regulating works which will control the water in the lake.

Mr. STEVENS: Then you see no element of unsafety in the construction of the spillway?

Major SIBERT: No, sir. We propose to blanket all that hill; to excavate on the south face of the hill until we have passed through the strata that carry water the most, and to cover that face with concrete and let that join on to the sheet piling, and then we propose to cover with concrete all exposed rock surface to which the lake will have access, so that no water can get into this rock; and we purpose to blanket the south face of Spillway Hill with impermeable material, pumping it there as in the dam, thus practically shutting off the lake from this hill. It is a small hill isolated by these gorges.

THE POSITION OF MAJOR SIBERT IN THE CANAL COMMISSION.

The extremely important facts stated by Major Sibert make it necessary to know that he is the responsible head of the locks and dam construction at Gatun.

Mr. STEVENS: What is your position, Major, in the Canal Commission and its work.

Major SIBERT: I am a member of the Isthmian Canal Commission and at present in charge of the work in the Atlantic division. This work includes the construction of the Gatun locks and dams, the excavation of the sea-level dortion of the canal in that end, and the construction of any works necessary in Colon Harbor.

* * * * * * *

Mr. Stevens: When did you come to the Commission?

Major Sibert: I left the United States March 10, 1907.

Mr. Stevens: Since that time you have had charge of lock and dam construction at Gatun?

Major Sibert: Yes; I had charge of all lock and dam construction on the canal until last July, when the work was divided according to territory and not according to class of work.

WHAT IS THE CONTROLLING ELEMENT OF THE SAFETY OF THE GATUN DAM? WHAT WILL OCCUR IF IT FAILS?

It will be seen by Major Sibert's testimony that the controlling element of the stability of the Gatun dam is in his opinion the one I denounced in the New York Herald of December 12 as unsafe, the soft blue clay. The danger of destruction he foresees is only the lowering of the crest of the dam below the water level of the lake. It does seem however certain that also in case of the settling of a part of the dam fissures will be opened between the part in motion and the one which will remain in place and outlets through the dam will be offered to the waters of the lake which will result in an immediate destruction.

The important thing nevertheless is to register the facts brought out in the following quotations of the distinguished officer.

Mr. Hubbard: You are building an earth dam there, I understand. So far as the dam is concerned, you do not expect, and perhaps do not want, a rock foundation except as to the spillway?

Major Sibert: I would like to have a rock foundation wherever I can get it.

* * * * * * *

Mr. Richardson: You say you would rather have a rock foundation?

Major Sibert: Yes, sir.

Mr. Richardson: Because that more certainly can balance—can bear the great weight, can carry any load that comes on it. It is your opinion that it will resist all pressure and that it is absolutely safe, which is based on the fact that you believe that you have got at Gatun dam a safe foundation?

Major Sibert: We have not a rock foundation there under the dam, but under the locks we have.

Mr. Richardson: Is it not a fact that on the safety of the foundation of he dam the whole canal depends?

Major Sibert: Yes, sir.

Mr. Hubbard: Judge, allow me to ask if you are distinguishing between the lock or dam, and if you are speaking of the Gatun dam?

Mr. Richardson: Yes; I am speaking of the dam.

Major Sibert: *The success of the dam depends upon having a good foundation. If you can not build the Gatun dam, you can not carry out the present project.*

* * * * * * *

Mr. Richardson: And it is not true that all the precautions you can take in putting in material to resist the pressure of the water, that if the foundation is not good, all that counts for nothing?

Major Sibert: *If the foundation will not bear the load, we can not build and maintain the dam.*

Mr. Knowland: But in your opinion, Major, you think it can?

Major Sibert: I think the dam can be built.

Mr. Knowland: And will hold?

Major Sibert: I think so.

* * * * * * *

Mr. Stevens: What doubt is there about the dam itself? Where is its weakest point?

Major Sibert: *The only weak point in the dam is its foundation.*

Mr. Stevens: Over the whole length of it?

Major Sibert; No; not over all of it. *Over that part of it where this blue clay, this slippery clay, comes closest to the surface.*

* * * * * * *

Mr. Stevens: Then, we are getting down to the crux of the danger of the whole proposition, viz, that some of the underlying material in the gorge, the treacherous portion of it, may slip through for various reasons. If that should happen, what would be the result as to the portion of the dam immediately over that slip?

Major Sibert: *If the material under the dam were displaced—enough of it—to let the dam down so that water could run over the top of it, it would all go out.*

Mr. Stevens: *What precautions are you adopting to meet that possible contingency?*

Major Sibert: *You can not adopt any.*

THE NEW METHOD RESORTED TO IN ORDER TO PREVENT THE ESCAPE OF THE SOFT CLAY FROM UNDER THE DAM.

Major Sibert explains how it is hoped to prevent the soft material from escaping from under the dam by loading laterally the natural ground on both sides of the dam, so as to prevent it from rising by the upward pressure of the clay underneath when pressed out by the dam.

This is a method which has no antecedent and at which no engineer should look complacently.

The soft clay must be considered as a semi-fluid matter. The transmission of the pressure it sustains at a given point is entirely dependent upon its stage of fluidity.

Nobody knows nor can calculate what will be the fluidity of the soft clay or even of the stiffer variety met under the dam location when the water will be allowed to rise behind the dam.

The conditions of equilibrium obtained during the construction of the huge earth embankment will not in the least resemble those which will exist when the lake will be formed.

The incessant movements of the clay below, which are already apparent with the relatively small load of the rock toes on the ground, will continue and cannot be but expected when the dam is in course of erection, and when the pressure exerted on the ground will gradually rise to perhaps eight times more than the rock toes determine.

The movements which Major Sibert expects during the erection of the Gatun dam as an earth embankment will have largely disintegrated the clay, will have allowed it to absorb more water and increased its fluidity.

Admitting a satisfactory equilibrium be obtained for the earth embankment, it will not in the least give the slightest indication as to what will be the equilibrium with the water behind.

The pressure of two and a half atmospheres which will be that of the lake water on the base of the dam, will inject into the clay a new mass of liquid element which will increase its fluidity. The conditions of the former equilibrium which are determined by the fluidity of the clay will be then entirely and radically altered for the worse.

Major SIBERT: As I stated before, I think we can build a dam there on all the foundation.

Mr. STEVENS: Let us analyze the matter, Outside of this soft part, what reason is there to doubt its safety? What factor is there which would cause it to be unsafe out of the soft part?

Major SIBERT: None, except the ability of this material to stand the load, and it is so far down as to be out of the question.

Mr. STEVENS: Then you would not question that part of it?

Major SIBERT: No, sir.

Mr. STEVENS: As to the treacherous part, what are you doing to overcome the difficulty?

Major SIBERT: *We are so balancing, so arranging, the material north and south of the dam as to prevent any displacement of this material that we are now speaking of.*

Mr. STEVENS: Is that a matter of *calculation or experience?*

Major SIBERT: Largely a matter of *experience.* We get on the Isthmus a great deal of experience in that line in connection with the dumps, and especially with the fills of the Panama Railroad, and it is in these two lines that our experience here lies.

Mr. STEVENS: Now, if your experience shows that a mistake has been made, and the balance can not be created at the time you expect, what happens?

Major SIBERT: During construction, if it happens, we continue to put more material in, and add more load above and below the dam, and continue building until we have a structure that will stand.

Mr. STEVENS: You just continue?

Major SIBERT: Just continue; that will be done before the lake is formed.

Mr. STEVENS: What tests are you making to continue your experiments in the line of balancing as to this treacherous or deficient portion?

Major SIBERT: We will make no tests, except actual test of building. That is the only way we can load it, as it goes up. If there are slips, and there may be slips, we will meet them as we go along.

Mr. STEVENS: Then, you expect more slips?

Major SIBERT: Yes; I expect more slips.

Mr. STEVENS: Constantly.

Major SIBERT: I expect slips.

Mr. STEVENS: Do you consider it as a part of the dangers to that treacherous portion that there may be underground seepage?

Major SIBERT: I do not; that is, no deep seepages. *I am rather of the opinion that that part which is soft is made soft by water seeping from the hill.*

Mr. STEVENS: And that would be the utmost damage that would be caused by seepage?

Major SIBERT: I can imagine no damage to this dam caused in any other way than by slips. I believe the dam to be water-tight, and if water-tight no current can get through it. Settlement and erosion are the only two things, barring earthquakes, and if it is impermeable, as I think it is, bottom and top, I believe we can get no current of water in it that will destroy its foundations.

Mr. STEVENS: So that the real danger is in the unequal distribution of loads over the treacherous portion, causing slips?

Major SIBERT: That is the only thing that I know of, and that ought to be met in the building.

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Major SIBERT: If it ever let any water through at all, it would go; that is, at the top. *If it settled so that a little stream as big as your finger started over the top of the dam, it would go?*

Mr. STEVENS: So you have to have a dam large enough to meet any question of subsidence for some years to come?

Major SIBERT: It would be better to so build it as to absolutely remove all risks of subsidence. *If it starts after the dam is built, it is difficult to say how far it will go.* It is best to meet it in the beginning.

Mr. STEVENS: In what way are you meeting it?

Major SIBERT: We are meeting it by so placing the loads above and below the dam as will prevent subsidence, and will prevent any movement of material from under the dam.

Mr. RICHARDSON: When you speak of so balancing the material, what do you mean? You have a dam so wide and so high, constructed by the pumping of certain material. What do you mean by so balancing this material?

Major SIBERT: The heaviest load on the foundation will be under the highest part of the dam. If the material on which the dam rests is not confined it must buckle up somewhere, if overloaded. If it can not move, the dam can not settle. We are adopting the plan of extending the fills above and below the dam, so as to weight down the ground to such an extent as to confine the material under the dam in case it should be overloaded. If the underlying material can not move the dam can not settle.

Mr. RICHARDSON: This balancing method consists of making the bottom of the dam exceedingly wide?

Major SIBERT: Yes.

Mr. RICHARDSON; Then the balancing you speak of takes place when you make the plans for the great width of the dam, and not when you dump the material?

Major SIBERT: The dumping of the material is simply carrying out the plan. The plan is to carry the toes so far as we have material to carry them, and so extend them as to balance the pressure of the dam.

THE REASON OF THE SLIDE OF THE ROCK TOE WAS NOT THE SILT IN THE OLD FRENCH CANAL, IT WAS THE LACK OF SUPPORTING POWER OF THE BLUE CLAY UNDERNEATH.

Major Sibert gives a very clear explanation of the reason of the slip of the rock toe at the crossing of the old French canal. He, at the same time, says that there were many other slips which show how the subground is working already under the relatively light pressure of the rock toes.

Major SIBERT: We pumped out of the Chagres and canal and will pump out of the west diversion all silt deposited by the streams, so as to get down to the original geological formation, and allow the superstructure of the dam to come in direct contact with this material.

Mr. STEVENS: Then this slide took place in the French canal?

Major SIBERT: *We have had several slides.*

Mr. STEVENS: The large one—now, would it not have been more reasonable to expect this slide in the channel of the old Chagres River?

Major SIBERT: Not if you examine the profile. There is underlying this dam a stratum of dark-blue clay of various degrees of consistency. In some places it is quite soft, and in some places harder. Overlying that is a stratum of a yellow mixture of sand and clay of varying thickness. In some places this blue clay is at sea level. In some places it is in the neighborhood of 70 feet below sea level. The thickness of the overlying sand and clay varies accordingly. That is about the general condition. The material upon which the slip occurred in the French canal is much nearer the surface than such material is under the Chagres River. There were some little subsidences is crossing the Chagres, but not such as had occurred in crossing the French canal.

Mr. STEVENS: *You have not had any slip in the north toe?*

Major SIBERT: *Yes; a good many small ones.*

Mr. STEVENS: And you anticipate more as the work increases?

Major SIBERT: That would be the natural assumption. There is quite a soft place at the end, and there *have been considerable gradual subsidences and the tracks have to be raised to keep up to level.*

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THE FISSURATIONS OF THE ROCK IN THE NEIGHBOURHOOD OF GATUN.

Major Sibert in speaking of the aprons or curtains of masonry to be constructed below and in front of the foundations of the Gatun locks in order to prevent the water from flowing underneath the locks and undermining them says:

Major SIBERT: Yes, sir. This country is fissured, I do not know to what depth, and you do not know that that curtain wall is down below all the fissures and is cutting out all access to the fissures.

THE EFFECT THE UNDERGROUND FLOW OF WATER MAY HAVE ON THE RESISTANCE OF THE FOUNDATION OF THE LOCKS AND OF THAT OF THE MASONRY DAM IN GATUN ISLAND.

Major Sibert recommends a very solid floor for the locks because he fears that the water if allowed to pass through fissures of the floor will disintegrate the foundation and he gives a striking example in point.

But it must be remarked that the same effect will take place if the water passing through the fissures open for themselves a new outlet near the dam. This seems to be nearly certain.

The actual outlets, believed to be in the sea, would evidently be changed for very near ones under a head of 85 feet of water such as will take place when the lake is formed. This seems highly probable because the strata of ground which may counterbalance a head of 8 to 10 feet will not do so with a head of 85 feet. In such case the velocity in the crevices will be enormously increased and the disintegrating influence on the ground correspondingly increased.

The CHAIRMAN: You say a secure and efficient lock may be had?

Major SIBERT: If you can prevent the breaking up of the lock floor.

The CHAIRMAN: Why do you make this condition, when you say as an engineer that you can have a safe floor to your lock?

Major SIBERT: In the investigations to determine the character of the material under this lock we dug a test pit near the lock site, going down through the same material that is encountered in the foundations of this lock. We came down to this soft sandstone of a blue variety, and we placed on that a test load of 500 pounds to the square inch, and that load finally—the whole thing—turned over, and *an investigation of it afterwards showed that the particles of sand in that stone were carried out by erosion caused by ground water coming up and escaping at the edges.* If we give any outlet to this water, this same thing is liable to occur by the water passing through these crevices in addition to the ground water which did take this sandstone away. If the water has no outlet, it must go on, as it always has done for centuries, through the small crevices in this rock to the sea, and the further it goes the less power it has to do damage, as it loses head by friction, and it can scour nothing if it can go on its old road to the sea.

It is not out of place to remark that the pressure of the masonry on the ground will not be very far from the experimental pressure of 500 pounds to the square inch which ended as Major Sibert just described by the tipping over of the load.

We have the necessary information from Major Harding's testimony.

Mr. STEVENS: What is the action of blue sandstone under water, air, and pressure, such as in this lock foundation?

Major HARDING: An actual test load of 500 pounds per square inch was made on the blue soft sandstone, which during the period of the test was exposed to the atmosphere, and from which the water was excluded. Under the test load of 500 pounds per square inch there was no settlement of the material.

Mr. STEVENS: What would be the load of the lock wall?

Major HARDING: The maximum pressure occurring per square inch under the most adverse conditions of loading, which conditions would be of a temporary character, is 250 pounds per square inch.

THE FISSURES IN THE GROUND COMMUNICATE WITH EACH OTHER. EXPERIMENTS SHOWING THE CONNECTION TO EXIST IN ALL DIRECTIONS ON A DISTANCE OF 2000 FEET.

A shaft was dug on Gatun hill where the spillway will be erected; another was dug on the location of the locks. Major Sibert gives figures which any engineer will find extremely discomforting, to say the least, as to the intensity of the flow through these fissures and the demonstrated connection between these fissures.

Mr. STEVENS: In pumping out the shaft at the spillway, what effect had it in lowering the level in the test holes along the dam?

Major SIBERT: There was one hole in the spillway that was artesian and about 640 feet away from the test pit. We made no systematic observation, but when we pumped out the test pit the flow stopped in the artesian hole, which showed the connection.

Mr. STEVENS: What was the remotest test pit from the shaft that was affected by the pumping-out process?

Major SIBERT: That was the only one observed. *We carried on systematic testing on that line at the locks. There the effect was noticed as far as 2,000 feet away.*

Mr. STEVENS: Was that test hole east or west or north or south of the shaft?

Major SIBERT: North of the shaft. *It lowered the water in the holes in every direction, but we had the longest line of holes in the direction of the lock, north to south.*

Mr. STEVENS: *That would indicate the connection of all the test pits with the shaft?*

Major SIBERT: *Yes, sir.*

Mr. STEVENS: That connection, you think, was through fissures or the waterlogged mass of material?

Major SIBERT: I think principally and almost entirely through small fissures.

Mr. STEVENS: Of course your pumping-out process hastened the flow?

Major SIBERT: Toward the pit—yes, sir.

Mr. STEVENS: You believe that when the dam is completed, as you now plan it, the underground flow will be practically eliminated, if not stopped?

Major SIBERT: You mean the dam or the lock?

Mr. STEVENS: Well, both.

Major SIBERT: *I think the underground flow under the locks will be increased somewhat when the lock is finished.*

Mr. STEVENS: *By reason of the head?*

Major SIBERT: *Yes, sir, by reason of the head.* If that water gets no outlet anywhere, I do not see how it can do any harm. It has been traveling that way for centuries through these crevices. If it cannot get any outlet nearer than its present outlet, which is undoubtedly in the sea, the distance will be so great that the head will be so reduced, as it has been for ages past, that there can be no enlargements of the fissures. If it has an outlet, I would expect some scour, as has been seen in the test pit dug at the locks in the soft sandstone of the black variety.

Mr. STEVENS: *What was the rapidity of the flow in the test pit?*

Major SIBERT: *We got, I think, between 38,000 and 40,000 gallons per day.*

Mr. STEVENS: What was the diameter of it?

Major SIBERT: About 6 feet square—maybe a little larger; big enough to go into and to excavate by hand.

Mr. STEVENS: With the method of cut-off of the underground flow, due to a head of 85 feet, as described by Major Harding, will you have reduced the underground flow to a point where it would not endanger the foundations of your locks?

Major SIBERT: *Personally, I do not think it practicable to cut off this flow entirely, because we do not know the depth of these fissures, and consequently we do not know for certain that we can keep the pressure of the lake from under our lock floors by the curtain wall.* I think the flow of water under the lock foundations would be diminished, but I do not feel certain that we would not get a head of water under the floors with this curtain wall.

THE AMOUNT OF WATER TO BE LOST THROUGH THE FISSURES OF THE HILLS CANNOT BE DETERMINED. "IT IS A CHANCE WE HAVE TO TAKE ON THE PROPOSITION," SAYS MAJOR SIBERT.

To operate the lock canal with a dam at Gatun the preservation of all the waters brought by the Chagres and its tributaries is necessary in the strictest degree of the word.

If not one drop of water is lost by going to the sea the maximum traffic the canal can serve will be between 40 and 67 million tons annually according to the future average size of ships (an average size of 3,000 tons, say the actual average of the Suez Canal, corresponds to 40,000,000 tons and an average size of 5,000 tons to 67,000,000 tons).

To what figures will this maximum be lowered if the fissurated hills allow a part of the water stored to go to the sea? This is a matter of the greatest moment. The loss will take place. It is established. How much water will be lost? Nothing can determine it. And the very life of the canal depends upon it!

Under a head of 35 feet a little hole about six feet square has received from the fissurated ground 38 to 40 thousand gallons of water in 24 hours. This is about one forty thousandth part of the maximum supply of water that will be available for lockages in the dryest years, if not one drop of water goes to the sea except through the locks.

What will such a ground draw from the water reserve in the lake and send unused to the sea, with a head twice and a half greater, when the same ground will be in contact with the lake on many miles?

What will become of the loss of water through the fissures after a few years, when the rapidity of the current will have enlarged them by disintegrating the soft argillaceous sandstone upon which the water will run?

These are questions which cannot be dismissed as generated by an absurd scare, as Major Harding did before the Congressional Committee. These are questions which cannot be dismissed either "as a risk to be taken," as Major Sibert did before the same committee, as will be seen hereafter.

These questions involve the fate of the canal itself. If the Gatun hills are a sieve there will be no lake and if there is no lake there will be no canal after ten years' work after nearly $400,000,000 expenses.

These questions must be answered, they should be one of the principal preoccupations of the authorities.—CAVEANT CONSULES!

Mr. STEVENS: Now, there are two saddles in the surrounding hills. Have you made any examination of these?

Major SIBERT: Only from borings that have been made. Some of these hills are not close. One saddle is quite close, but not the one on the Trinidad?

Mr. STEVENS: What is the height of that saddle above the lake level?

Major SIBERT: For a considerable distance it is only a few feet.

Mr. STEVENS: That would be soft earth, would it not?

Major SIBERT: Earth and underlying material. It would be necessary to increase the height of that saddle.

Mr. STEVENS: Has there been any boring in these saddles?

Major SIBERT: An attempt was made in the beginning to make a spillway there instead of through the dam, but the underlying rock bottom was not of sufficient hardness to justify this.

Mr. STEVENS: But the material was safe enough in your judgment to prevent any seepage in that direction?

Major SIBERT: *Well, I do not know very much about that. I did not make any experiments in that direction.*

THE CHAIRMAN: Has any other gentleman any questions to ask?

Mr. HUBBARD: I understand you to say, Major, that it is perfectly feasible to build this structure so that it will be safe, and that the floors can be constructed so as to prevent the upward pressure of water through the lock floors?

Major SIBERT: That is my opinion. *Major Harding thinks that by building a curtain wall you will cut off the flow, but I differ with him there.*

Mr. HUBBARD: You see no value in the curtain wall, then; you do not think it will cut off the flow?

Major SIBERT: Well, I think it will not cut off the flow entirely.

Mr. HUBBARD: Your statement was that the safety of the structure was conditioned on the floor being so constructed as to prevent water flowing through the floors?

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Major SIBERT: I feel that the locks and dams can be built. There is some chance of danger in the Gatun dam foundation, but I do not think it is material enough to constitute an obstacle. It is in the range of possibility that some slips might happen, but whether it is in the range of probability or not, I do not think it is. That is, the slipping of the underlying material of the Gatun dam. That, to my mind, is the only weak point in the scheme, if there is a weak point. *As to the water supply of the lake; the question of seepage loss, not under the Gatun dam, but through the hills around it, that is a question we can only guess at.*

The CHAIRMAN: Has there been no such explanation made as will enable you to say that after your work has been accomplished, and you have got your 85 feet of head, that all that may not be destroyed by the escape of these impounded waters by fissures you do not know anything about?

Major SIBERT: We know it will not escape over any low places in the surrounding hills, but *we do not know with any great degree of definiteness the character of the rock and of the material constituting the rim of the lake.*

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Mr. HUBBARD: That is, if you were set to execute a piece of work according to somebody else's plan, and had come to the conclusion that it could not be carried out, there would be a way to make it known with propriety to some one?

Major SIBERT: I would not build a thing I did not think would stay there, unless I had notified some one in higher authority than myself of my fears, and this higher authority assumed responsibility for the plan.

Mr. HUBBARD: Have you ever felt such a desire to make a report?

Major SIBERT: I have always had confidence in the Gatun dam. and these difficulties, which are not serious, which we are encountering now are the only things that have happened to throw any discredit on the scheme, and that is entirely in the foundation. I have not had sufficient data to form any definite conclusion as to loss of water by seepage in this lake, and that is a question I have no thorough way of investigating; *it is a chance we have to take on the proposition.*

Mr. STEVENS: I do not know if it is serious or not; it would be if you could not hold the lake.

Major SIBERT: *It is an unknown field to me.*

Erratum.

[An error made in composing this pamphlet has caused the following chapter, which should have been printed on pages 46 and following to be omitted. It is not perhaps to be regretted that it was placed apart on account of its importance.]

WHY WAS THE STRAITS OF PANAMA OBJECTED TO BY THE INTERNATIONAL CONSULTING BOARD IN 1906?

It is easy to see from the records that this rejection was purely based on the false assumption that the transformation of rock into dredgable ground would cost $2.35 when it has been officially demonstrated since to cost eleven times less in the Suez canal and eighteen times less in the Manchester canal.

The cost at Panama of that transformation would be certainly inferior to the cost at Manchester, not only on account of the saving in expense due to the gratuitous mechanical power given by the falls of the Chagres, but also and principally on account of the extremely soft character of the greater part of the Isthmian rocks.

To demonstrate this important fact it is sufficient to quote what can be found on page 93 of the report of the Isthmian Canal Commission of November 16, 1901. This report cannot be accused of any bias in favor of Panama because it recommended the Nicaragua solution.

Speaking of the central mass of the Isthmus where the greatest quantity of hard material is accumulated, the report says: "The summit cut is 7.91 miles long from the Obispo "gates to the Pedro Miguel locks. * * * There is a little "very hard rock at the eastern end of this section and the western two miles are in ordinary materials. The remainder con-"sists *of a hard indurated clay* with some softer material at "the top and some strata and dikes of hard rock. In fixing "the price *it has been rated as soft rock, but it must be given* "*slopes equivalent to those in earth* * * * probably *nine-*"*tenths of the material would naturally be classed as hard clay*" *of stable character.*"

This description will better than anything else give a correct idea of the general character of the isthmian rocks. Except for a few points there is no hard rock. The bulk of the hard material encountered is a volcanic hard clay very similar to the soft rock met in certain Japanese harbors, where the cost of the transformation into dredgable matter is still much lower than the Manchester canal figure. In these Japanese harbours it approximates two cents a cubic yard, and, therefore, is one hundred and seventeen times cheaper than the Consulting Board determined.

Another description of the nature of the Culebra cut was given by Mr. Stevens, then Chief Engineer of the Canal, to the Consulting Board in 1905 and can be found in Appendix J of their Report (page 286). Though worded differently it absolutely confirms the description of the Isthmian Canal Commission reproduced hereabove.

Mr. Stevens * * * "*I regard the whole Culebra cut as*" *a soft-rock proposition.* While it is true that a shovel" would pick up some of it without blasting, you can do it all" much more economically to shoot it. * * * As far as I" have been able to observe, you can classify the Culebra" above as red clay overlying argillaceous schists, with hard" igneous trap thrown up through it. A great many borings" have been made. It is a mixed conglomerate mass."

Mr. Stevens further explains what is the general character, as to hardness, of the Culebra Cut on page 289 of same report.

MR. PARSONS: Taking the Culebra Cut from Obispo to Paraiso, averaging it all through, you would call it a soft-rock proposition ?

MR. STEVENS : *What I would call hard trap is not large,* therefore to average it right through it is a shooting proposition. *Any argillaceous schist is always soft.*

Another estimation of the nature of the ground of the Isthmus was made in 1905 by the Isthmian Canal Commission for the sea level project which they submitted to the International Consulting Board. It was exceedingly prudent and even pessimistic. They based their estimates on one fourth loose ground, one fourth rock, one half soft rock.

If we suppose the dredges employed will be bucket chain dredgers of the french type, the bucket capacity being one cubic yard and a half, a daily (24 hours) practical excavation of 10,000 cubic yards may be confidently expected for each dredge. Therefore twenty dredges in a month of 25 days will excavate 5,000,000 cubic yards say 60,000,000 cubic yards a year and 600,000,000 cubic yards or the entire cube of the " Straits of Panama " within ten years.

Admitting for the real rock the lesser advantageous proportion of one fourth instead of one tenth we see that 15 rock breakers will be necessary for each dredge. (10 breaking 250 cubic yards each daily of real rock and 5 breaking 1,000 cubic yards of soft rock.)

Mr. Kellennec, chief engineer of the Suez Canal, in his report on rock dredging at Suez to the conference of Civil Engineers in London, 1907 (Transactions of Section II.) says that the average number of blows had been 7.1 per cubic meter and the number of actual blows delivered in one hour 115 (after eliminating the loss due to the passage of ships in the narrow Suez Canal). This gives 22 cubic yards per hour or 528 cubic yards daily.

This shows how conservative is the figure of 240 cubic yards I just admitted for the real rock in Panama, it allows for an average hardness making necessary twice more blows than at Suez. It corresponds to the hardness of the gneiss excavated in the outer bay of Brest harbour where 15 blows were found necessary per cubic meter as an average.

Mr. Kellennec further states that certain parts of the rock was extremely hard and sometimes but rarely made forty blows necessary, but that on the other hand *one blow for soft rock* was sufficient to shatter one cubic meter.

In the inner harbour of Brest the hardest and most compact silica was found which required 60 blows.

These figures demonstrate that the concussion system does never find rock of sufficient hardness to stop its use.

Of course the number of blows varies with the hardness of the material.

Very misleading information might cast a doubt on the efficiency and the cheapness of the method if taken at a given point where the hardness of rock is excessive and where there are not a sufficient quantity of rock breakers at work to keep a powerful dredge busy. Under such circumstances the total price might be unexpectedly high.

But this has no bearing on the subject now examined. Here the question is one of average as it was on the Suez Canal, as it was on the Manchester Ship Canal. In both these cases in spite of the very hard rock sometimes encountered the average cost was twenty cents and twelve and a half cents respectively. On the Panama Canal there is not the slightest doubt that the average will be lower than is the case of Suez and even of Manchester, because even the hardest rocks cannot be compared to the compact silica of the inner Brest harbour, and because they are in infinitesimal quantity. The great bulk of the real rock is not hard and the soft rock is more a hard earth than a soft rock, it is a dry, stiff clay which breaks and disintegrates very easily at the slightest shock.

THE "STRAITS OF PANAMA" FORMERLY A CHIMERA NOW A PRACTICAL AND TANGIBLE REALITY—THE MOST ECONOMIC OF PLANS.

The excavation of the 600,000,000 cubic yards would be chimerical if it were to be made in the dry, as the sponsors of the tide locked sea level canal propose to excavate the larger part of their 230,000,000 cubic yards. It would be chimeral in the wet system if the excavation of the rock below water should cost $4.75 a cubic yard, as the Isthmian Canal Commission erroneously believed in 1901. It would be chimerical also in the wet system, if it should cost $2.50 as the Consulting Board erroneously believed in 1906.

It is the most economic and at the same time the most perfect of all the plans if the removal of one cubic yard of material is brought by actual practical methods down to sixteen cents on an average.

There are enough official proofs of such a fact to justify an entire reconsideration of this capital question. If unbiased and free minded engineer officers of the army, having had no anterior connection with the plans under discussion, should be sent to investigate first the nature of the rock on the Isthmus and then to study in France, England, Egypt and Japan the actual improved methods of dredging soft and hard material the cloud would be soon dissipated. The supposed chimera would become a real tangible thing and the United States, the trustees of humanity in the construction of the great international waterway, would give to the World what it wants, what it is possible now and easy to obtain : "the Straits of Panama."

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IN

Rear-Admiral Daniel Ammen's Pamphlet

ENTITLED

"THE CERTAINTY OF THE NICARAGUA CANAL CONTRASTED WITH THE UNCERTAINTIES OF THE EADS SHIP RAILWAY."

BY E. L. CORTHELL, C. E.

APRIL, 1886.

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the hand of man, and it is drawn from an *uncompleted survey made thirty-five years ago* for another purpose, and so drawn as to exaggerate the elevations of the ground 235 times; that is, the points of land are 235 *times higher* than they would be if the vertical scale was the same as the horizontal.

ADMIRAL AMMEN'S WANT OF KNOWLEDGE AS TO TEHUANTEPEC.

The unfamiliarity of the Admiral with his subject is seen by his statement that "the map in the 'Scientific Solution' (The Interoceanic Problem and Its Scientific Solution, an address by the writer,) locates the Ship Railway *across* the *Chivela* and *Tarifa passes*." These two passes are totally distinct gates through the same chain of hills, and are *ten miles apart.*

Nearly two years were employed in surveying the line for the Ship Railway by as experienced, capable, and reliable engineers as can be found in the United States, and no expense was spared to obtain *all* the information needed to make the best location, and to form reliable plans and estimates of the whole work; not only has the railway route itself been thoroughly examined instrumentally but the approaches from the Gulf and the Pacific have also been carefully surveyed, and detailed plans and estimates have been made for the construction of works that will give a deep channel from the sea into the land-locked harbors.

The Admiral states that there is "marshy ground" both on the Atlantic and Pacific plains. This the writer positively denies, having been for many months upon the Isthmus, and having assisted in making actual instrumental surveys of the proposed line of the Ship Railway, from ocean to ocean. A profile has been drawn on railroad "cross-section" paper, under his supervision, from the detailed notes of an exhaustive survey, where every irregularity of the ground, its water courses, its slopes, and all its natural features are shown in as much detail as any good constructive engineer would show on the profile of a railroad location from which he intends to work up the final estimates of its cost and lay out the work for construction. This profile is 225 *feet* in length, and the estimates embrace every detail for the construction and equipment of the Ship Railway. Not only was one careful transit and level line run out on the ground, but, where necessary, several were surveyed, and all the lateral topographical notes were taken necessary to map out in detail the general features of the country, and to show, by contour lines, the details of the natural slopes for excavations and embankments. The surveys were made under the immediate charge of Mr. Martin Van Brocklin, a civil engineer of large experience and exceptional ability.

During two previous years of constant examination of this Isthmus, as chief engineer of the Tehuantepec Railroad, an ordinary gauge road, he had made himself minutely acquainted with the country. His remarkable success in the construction of the loftiest piece of railroad in the world, on the Arroyo Railroad of Peru; his position as chief engineer in the construction of the Sixth Avenue Elevated Railroad in New York, and his varied and extended experience as a locating railroad engineer entitles his report on the Ship Railway route to perfect confidence. For the information of the reader, and to corroborate the statements made by the writer, the following is quoted from this report:

"Through a distance of thirty-five miles from Minatitlan, the line is in an extensive alluvial plain, composed in all its lower portions of a heavy tenacious clay. In the higher portions, and in the small ridges that are encountered, a clay loam is found, with an occasional deposit of sand.

"The firm and tenacious character of the material upon which the road-bed will rest, and of which it will be composed, will secure the railway from any injurious effects of water. Leaving this plain, the line enters an undulating table-land, extending to a point fifty-five miles from Minatitlan, where it leaves the valley of the Coatzacoalcos river and follows a succession of broad valleys formed by the Jumuapa, Sarabia, Malatengo, and Chichihua rivers; between these valleys there are extensive table-lands, with no high or prominent dividing summit between them, but they are interspersed with isolated hills and detached ranges from one to five hundred feet in height, the whole forming an extensive interior basin, having a gentle inclination towards the summit, and bordered on its eastern and western sides by irregular mountain ranges, spurs of the main Cordillera that runs through the entire continent, and which makes at this point one of the most marked depressions to be found in its whole length. From this basin the line passes through a valley formed by a stream called the Pozo de Agua, to the plains of Tarifa, an elevated level plateau six miles in extent. Crossing these plains, the line reaches the Portillo de Tarifa, the lowest and also the most accessible of the many passes through this general depression in the main mountain chain. From the Portillo de Tarifa the line descends to the Pacific plains (reaching them 118 miles from Minatitlan) by a uniform grade," [1 foot in 100 feet, or $52\frac{8}{10}$ feet per mile; this is the maximum grade and there is only one place where it occurs] "following a succession of valleys through the intervening foot-hills. These valleys are generally narrow, having very abrupt slopes on their sides. Fortunately, the line can be kept near the bottom of the valleys, avoiding any difficult or questionable class of construction. The heaviest excavations will be in cutting through spurs of the hill sides, or through divides between adjacent valleys. Across the Pacific plains the line can be given almost any desired direction, the surface being remarkably even and uniform in character." * * * "Many varieties of valuable timber are found, very durable in character, and suitable for either permanent or temporary work in construction, throughout the entire line, with the exception of about twenty miles at each end of it.

"Good building stone is found near the line at short intervals after leaving the valley of the Coatzacoalcos river. Granite, limestone, sandstone and quartzite are among the varieties of stone available for purposes of construction.

"The principal rock cuttings to be encountered near the summit will be in a clay slate formation, limestone appearing at a lower elevation, and granite in the higher ranges on each side of the line." * * * "A careful instrumental survey of the bar at the mouth of the river shows that there is at ordinary tide, fifteen feet of water over it. Surveys and soundings made during the last thirty years give conclusive evidence that this bar has changed very little during that time. Borings to the depth of twenty-six feet encountered no other material than sand and clay, much the larger portion being sand; a stratum of clay was found at the bottom of the borings. This bar has a striking resemblance to the bar at the mouth of the South Pass of the Mississippi river, except that it has less than one-fourth the distance across it, from twenty-six feet depth of water on the inside to the same depth on the outside, and it can be deepened by the same methods that gave such remarkable results at the mouth of the Mississippi river."

The statements made quite frequently by Admiral Ammen that no actual location and profile have been made evidently need no further discussion, nor do any of the arguments, drawn from these misstatements, require further notice.

REVIEW OF SOME OF ADMIRAL AMMEN'S STATEMENTS ABOUT THE BILL NOW BEFORE CONGRESS.

In criticising the Ship Railway Bill, Admiral Ammen says: "There is, however, no mention in the bill of the maximum toll rate upon which vessels would be transported, it might be fixed at $4 and $8 per ton."...."Neither Mr. Corthell in his 'Scientific Solution,' nor Captain Eads in his bill gives the intended rate of toll over his proposed Ship Railway."

An examination of the bill shows that authority is given to the directors representing the United States and Mexican Governments to reduce the tolls whenever the net income is greater than ten per cent. on the capital of the Company, which is limited in the bill to $100,000,000. If Admiral Ammen and his co-projectors of the Nicaragua Canal are correct in the estimates they have made of the tonnage likely to use an Isthmian transit-way, it is apparent that, under the provisions of the bill referred to, no unreasonable tolls could be exacted from commerce. But, aside from this, it is absurd to suppose that the Company would, even if it had the power, impose such tolls as would drive commerce away from it. Certainly ten per cent. interest on the amount invested is not an unreasonable return to the capitalists whose money goes to construct the work.

Speaking of the test load of 3,000 tons, (increased by consent to 6,000, and the second year to 7,000 tons,) the Admiral says: "His vessel may be constructed to weigh 2,900 tons, built expressly to make a land journey, with a cargo of 100 tons!" The transportation of a vessel with only 100 tons of cargo would not be considered by the Board of Engineers, under whose inspection the test must be made, as answering the requirements of the law. The purpose of the law is to demonstrate the practicability of the work, and no one, unless his antagonism to the project has entirely perverted his judgment, would suppose that the transportation of a vessel, especially built for the purpose and of much greater strength than ordinary vessels, with a few bags of grain, or a few tons of iron as a cargo, would authorize or receive the favorable certificate of the engineers upon which is made to depend the Government guaranty.

In speaking of that clause in the bill which relates to filing a certified copy of the Mexican Concession with the Secretary of State of the United States, within three months after the date of the passage of the act, Admiral Ammen says: "The bill recites that a favorable concession exists, the terms of which are to remain unknown to our legislators." This is another grossly inaccurate statement. A certified copy of the Mexican Concession has been in the hands of the Commerce Committee of the House during all its discussions, and it and all papers relating to it have been at their disposal. The minority report of the Committee gives the Concession in full.

WAR VESSELS.

On page 5, Admiral Ammen makes the statement that a war vessel would not float after being transported over the Isthmus on the railway. This statement is in conflict with the opinion of a host of the most prominent naval constructors and shipbuilders of the world, and as Admiral Ammen could no doubt command a ship much better than he could build one, and as he stands almost alone in his opinion on the subject, his views are not likely to have very much force. Among the many who differ with Admiral Ammen on the subject may be included the names of Commodore Theo. D. Wilson, the present Chief Constructor of the U. S. Navy; Commodore J. W. Easby, late Chief Constructor U. S. Navy; Mr. Nathaniel Barnaby, Chief Constructor British Navy; Sir Edward J. Reed, late Chief Constructor British Navy. These gentlemen have given the most decided opinions in favor of the entire practicability of transporting laden vessels on a railway.

THE HARBORS.

Admiral Ammen refers to the "factitious presentation of science in the 'Scientific Solution,'" and proffers some information in regard to the harbors which is entirely erroneous. He says: "The 'Scientific Solution' assumes that good harbors either exist, or making and maintaining them is a bagatelle, and the Eads' bill presupposes the fact that a good harbor on both coasts is known to all men; has the great engineer lost his faith in his knowledge of the Jetty system, or has he so solved it that it gives him no concern?" The facts in regard to the harbors are fully given in a paper published by the writer about the first of January, 1886, entitled, "The Atlantic and Pacific Ship Railway." Careful surveys, plans, and estimates have been made of these harbors, and their exceptional advantages for both maritime and strategic purposes have been fully stated in several publications. The writer, having spent a month surveying the bar at the mouth of the Coatzacoalcos river, and having had some little experience in river and harbor hydraulics, is perfectly confident that the plans for deepening this bar from 15 feet, (*not* 13 feet,) now existing, to 30 feet can be done at the estimated expense, which is not great. The "harbor" subject is a very tender one with Admiral Ammen, because of the total want of harbors at the termini of the proposed Nicaragua Canal. What was once a harbor at Greytown is now wholly destroyed. The San Juan river, to the current of which was due whatever depth of water ever existed at Greytown, long ago deserted its old bed, and now discharges its waters, through the Rio Colorado, in Costa Rican territory. There is a careful avoidance by Admiral Ammen and his friends of all discussions of Nicaraguan harbors.

EARTHQUAKES.

Those informed on the Isthmian question will be surprised at the Admiral bringing forward the danger from earthquakes to the Ship Railway; it being well known that the greatest prevalence and most marked results of earthquakes are *along the line of the Nicaragua Canal.* The actual perversion of facts, by quoting only a part of a statement made by Rear-Admiral Shufeldt, on page 106 of the latter's report, is especially marked. The following, on the *same page,* but omitted by the Admiral, will show how he has perverted what Shufeldt said on this subject:

> "The singular freedom of this region from volcanoes, both active and extinct, and, in consequence, the less probability of violent earthquakes, is certainly an important consideration in favor of the Isthmus of Tehuantepec."

The Admiral brings up another objection, which was brought forward by him three years ago and then refuted, as to the prevalence of high winds on the Tehuantepec Isthmus. He says:

> "Were it to be conceded that earthquakes were exceptional, or that were they to occur they would do no more harm to the vessel than would be done 'to the load of hay passing over a stony road,' another difficulty presents itself in the 'northers,' of which Shufeldt makes mention on page 107:
>
> "'The northers that are so common in the winter season, never bring with them rain as they generally do on the Atlantic slope and on the table-

lands, but instead clouds of dust and drifting sand are caught up by these violent winds, and are driven across the plain in a southerly direction, and finally fall in the Pacific Ocean.' "

The following paragraph from the report of Mr. Van Brocklin, who, as before stated, has spent several years on the Isthmus, is sufficient proof of the absence of destructive tornadoes:

> " By reason of the peculiar topographical formation of the Isthmus, there is an almost constant interchange of air currents between the two oceans. The direction of such winds as are prevalent, coincides very nearly with the line of the railway. The very frail construction of the principal portion of the houses on the Isthmus, covered as they are with large and high palm roofs, extending beyond, and generally separated from their walls, the exposed places in which many of them stand, and the absence of any evidence of injury to them, induces the belief that very strong winds are unknown on the Isthmus."

(See also the recent letter of Mr. Van Brocklin, page 31, and that of Mr. Thayer, page 33.)

This statement agrees with the observation of the writer, and of other engineers who have remained there any length of time.

·EXCESSIVE RAINFALL.

On page 8, the Admiral speaks of the excessive rainfall on the Isthmus of Tehuantepec, saying: " I may add of rainfalls of 23 inches in as many hours." If he intends by these words to convey the impression that 23 inches of rain falls in 23 consecutive hours, the statement is a misrepresentation as regards any part of Mexico, and shows the Admiral's ignorance of the conditions existing at Tehuantepec. The actual gauging of the rainfall shows the total for one year to be about 100 inches near Minatitlan, the Gulf terminus of the railway. The record at Nicaragua shows an annual downpour of 102 inches, with nearly 6 inches in one day. The railway has the advantage of being built *above the floods*, while the canal must be *underneath them.*

PRACTICABILITY OF THE SHIP RAILWAY.

In reference to the practicability of constructing and hauling ships over a railway, a question which seems to be unsolved in the mind of the Admiral, it is proper to say that as the Ship Railway Company agrees to construct its railway and put it into successful operation before the guaranty asked for attaches, the question as to whether it is practicable to build and operate it is one of little importance to the Government. The report of the House Committee on Commerce contains the following:

> "It is apparent that under the terms of the guarantee the question as to whether a ship railway is practicable is one with which the United States Government has very little concern. If any part of the guarantee was to take effect before final completion of the work, the question of the practicability of the project would be a vital one; but inasmuch as the capitalists who advance the money to construct the road assume all of the engineering risks involved in its construction, and inasmuch as it must be practically demonstrated to be a success before the Government becomes liable to pay anything, the question of practicability is one to the consideration of which it is really unnecessary for Congress to devote itself. In this connection, however, it is but proper to say that in the opinion of the most able and well-known engineers, naval architects, and shipbuilders of the world the construction of a ship railway at Tehuantepec, in accordance with the plans which have been submitted to them by Mr. Eads, is entirely practicable. Indeed, many of these experts go much further than this, and declare that a railway is *preferable* to a canal, first, in the economy with which it can be constructed; second, in the facility with which it may be enlarged when commerce demands its enlargement; third, in the economy with which it can be operated, and, fourth, in its ability to transport vessels with greater rapidity and less delay."

ENGINEERS AND NAVAL OFFICERS WHO BELIEVE THE SHIP RAILWAY PRACTICABLE.

On page 9, the Admiral says: "Of the many recommendations of the railway in the 'Scientific Solution' there is not one of a railroad engineer." The following are the names of a few American civil engineers and railroad managers of the highest standing, who have carefully examined the subject and have pronounced the ship railway entirely practicable: Genl. William Sooy Smith, Henry Flad, H. D. Whitcomb, C. Shaler Smith, T. C. Clarke, O. Chanute, late chief engineer of the Erie Railway; Richard P. Morgan, Jr., a railroad expert of Illinois, and formerly one of the State Railway Commissioners; Clemens Herschel, of Boston; Charles Paine, past president of the Am. Soc. Civil Engineers; Col. H. F. Douglass, chief engineer Baltimore & Ohio R.R. Extension to New York; Jas. B. Francis, of Lowell, Mass., past president of the Am. Soc. Civil Engineers; Thos. C. Keefer, C. M. G., member Inst. C. E., London, Vice-Prest. Am. Soc. C. E.; Robt. H. Thurston, G. Bouscaren, E. T. Jeffery, general manager Illinois Central R.R., and to these we could add twenty or thirty more who have also expressed by letter their unqualified faith in its success.

But not alone among engineers is found numberless believers in the practicability of the Ship Railway. The Admiral will find scores of them in the Navy. The writer refers to a few of them, in addition to the two already mentioned, who have expressed themselves as confident that war or merchant vessels may be transported over land with safety on a properly constructed railway: The late Captain Edward Hartt, U. S. Naval Constructor; Mr. F. L. Fernald, U. S. Naval Constructor; Commander N. H. Farquhar; Rear-Admiral R. W. Shufeldt, U. S. N.; Rear Admiral S. P. Carter, U. S. N., and many younger officers of the Navy.

MANCHESTER SHIP CANAL.

On page 11 occurs the following sentence: "Despite of this assertion, the argument of our great Eads abroad that a canal was impracticable, and the obstruction for years by the railway interests of Great Britain, the Manchester Ship Canal is now in progress of construction." In this sentence are two misstatements. First, Mr. Eads *did not* argue that the Manchester Ship Canal was impracticable ; and, second, it is not as yet under construction. Mr. Eads appeared before the Committees of Parliament and proved that if the lower ten miles of the canal was located as proposed in the middle of the estuary of the Mersey, the works would rapidly reduce the tidal capacity of the estuary and ruin the Liverpool docks, and destroy that port. The Committee, after hearing Mr. Eads, rejected the bill unanimously, although it had been reported upon favorably by two previous Committees.

During the hearing, Mr. Eads suggested, in answer to a question of the Queen's Counsel for Manchester, that these ruinous results would not occur if these ten miles were located along either margin of the estuary. The plan was thus modified, and the bill for its construction has since been approved by Parliament.

NO CANAL AT TEHUANTEPEC.

On the same page occurs the following :

> "Section 2 of the Eads Ship Railway bill actually proposes the right to substitute canalization over any sections of his route deemed desirable by him, without requiring any stated rate of speed, or stating what the depth and prism of his canal would be! This effectually disposes of the pretension of speed across the Isthmus of Tehuantepec."......"But this proposed canal system of Captain Eads establishes the fact that he is aware that on these marshy and unsolid grounds a solid foundation for a Ship Railway could not be made save at an enormous cost, and then with very uncertain result, whilst the cost of excavating a canal prism would not be great, and would involve no doubtful result, except as to water supply and the establishment of necessary surface drainage."

This statement is doubtless due to a want of knowledge of the facts upon the part of the Admiral. In the concession this means a *channel*, and not a canal, between the Laguna

Superior and the Pacific. As a canal will cost about six times as much per mile as a railway, it would only be resorted to where the railway cannot be constructed. As the Lagoon on the Pacific side will be one of the termini of the railway, some work will have to be done in the nature of canalization to deepen and improve it, and this is the only work of the kind proposed.

In 1881, before any surveys had been made by us except to examine the passes through the central division, it was contemplated to locate the northern terminus on the Uspanapa, a large tributary on the right bank of the Coatzacoalcos; and fearing that within a few miles of the former the ground would prove marshy, a provision was put into the ship railway bill, then pending, providing for a canal through such portion as might prove unsuited for a railway. Further examinations led to the abandonment of that route and to the location of the line *on the other side of the Coatzacoalcos river.* From the northern terminus at Minatitlan to the Lagoon, 134 miles distant, not a single foot of marshy or even doubtful ground is encountered, and no canal whatever is needed.

SUEZ CANAL.

On page 12 the Admiral charges the writer with making, without any excuse, unreliable statements in regard to the rate of travel in the Suez Canal. What the writer stated was this:

> "In the Welland Ship Canal the speed is *one* mile per hour, and the same on the North Holland Ship Canal to the port of Amsterdam. (Internal Commerce U. S., 1885, p. 494.)
>
> "In the Suez Canal—the most important ship canal in the world—the time required to pass through, one hundred miles, was *fifty* hours, in 1884, or at a rate of *two* miles per hour. The average time of an undisturbed passage, in 1884, was 38½ hours. About 25 per cent. of the distance is through deep lakes, and 40 per cent. through shallow lakes, only 35 per cent. being through dry excavations. The speed by regulation

> is limited to five knots, but this is a dangerous one for steamers, for they are liable to run aground. From 1870 to 1883, *eleven* per cent. of all vessels went aground.
>
> "It was stated in evidence before the Canal Committee of Parliament that in 1882, the passage of ten ships through the canal would choke it."

The time of passage referred to is the *total time* required to pass through the canal, including the frequent groundings and delays by darkness and by waiting for other vessels to pass. The writer refers for confirmation of his statement to the "Maritime Canal of Suez," by Professor J. E. Nourse, U. S. N.; to a paper recently read before the Austrian Society of Engineers and Architects, in which it is stated that "the time of an *undisturbed* passage in 1884 was 38½ hours, while the total average, since opening the canal, is 41 *hours* 22 *minutes*." In that paper it is further stated: "The long time in passing the canal is a serious objection. The maximum speed allowed is five knots per hour. This and the time lost in the turn-outs makes the trip a long one." Reference is also made to the testimony of Mr. F. R. Conder, (who is a canal advocate,) taken before the Parliamentary Committee, June 21, 1883, page 127 of the report. Reference is also made to Vol. lxvi, p. 194, Proceedings of the Institution of the Civil Engineers of Great Britain, where Sir Charles A. Hartley says that the greatest speed through the lakes, where there is open and deep water, is, however, reduced to such an extent in the canal proper as to make the average through the entire canal less than five miles an hour, in which statement he refers to *effective* steaming, that is, the speed when the steamer is actually in motion.

NICARAGUA CANAL.

On page 13 of his pamphlet the Admiral quotes the writer as saying of the Nicaragua Canal:

> "The most complete and careful estimate of the cost of this work, made by Major McFarland, United States Engineer, is $140,000,000, with labor assumed at $1.00 per day."

The Admiral adds :

> "Mr. Corthell knows even better than the public that Major McFarland's 'estimate,' if it may be called by that title, was not on the line of the present location, so far as canalization is concerned, except from Brito to the junction of the Rio del Medio routes, a distance of eight miles, and that the actual line of canal excavation between the seas is now forty miles, in lieu of the sixty-one miles then given on instrumental surveys. He gives the distance from sea to sea at 186 miles, when it is 170, and the number of locks from 14 to 20, when there are but 7. Is Mr. Corthell really anxious to enlighten the public, or to abuse its confidence ? I am quite aware that he may plead ignorance; with what justice is known to him and others far better than to the public."

The above is wholly unjust. The survey of Mr. Menocal, establishing the length of the canal at 170 miles, and 7 as the number of the locks, making also other very important modifications in the location and plans on which Major McFarland made his estimates and which were before Congress last winter, was not given to the public until *November* 26, 1885, and then only in an article without signature in the American Engineer, of Chicago. The writer is charged with wilfully holding back information about these surveys and plans in an address delivered and printed *August* 26, 1885, *three months before.*

As to the abuse of the public confidence, what should be said of Admiral Ammen for bringing forward a profile of the Tehuantepec Route made from a survey of 35 years ago, and putting it before the public as the route of the Ship Railway, omitting entirely to mention an exhaustive survey made for this railway *two* years ago and published for the benefit of the public ?

The unfamiliarity of the Admiral with the plans of the Nicaragua Canal is seen in his statement, on page 14 of his pamphlet, that the locks are designed to lift ships of 30 *feet draught* from the Pacific to the lake level, although Mr. Menocal's table of depths shows that *nearly six miles* of the canal on this section is to have only 28 *feet depth,* and that *over* 40 *miles* of the Atlantic division is to have also only 28 *feet depth*, and that the locks themselves are to have only 29 *feet depth*.

Again the Admiral says: "Wherever the material to be excavated is not fully known through borings, it is given as rock and estimated for rock." He probably intended to say *absence* of borings, as there is no record of any having been made, and to consider the material as rock is really erring in favor of a low estimate, for the quantity and cost would be immensely greater, if it should prove to be earth in a cut nearly three miles in length, of an average depth of 150 feet. M. de Lesseps would be very glad to find solid rock in his great Culebra cut. The *suppressed* estimate of Major McFarland, made November 18, 1874, and only given to the public by Major McFarland himself, after much provocation, incites the ire of Admiral Ammen, whenever it is mentioned, for the reason probably that it is a *fair* estimate of the difficulties to be encountered, and of the cost of the work. The whole report shows a careful examination of the subject, and no doubt the Major is abundantly able to defend his estimate.

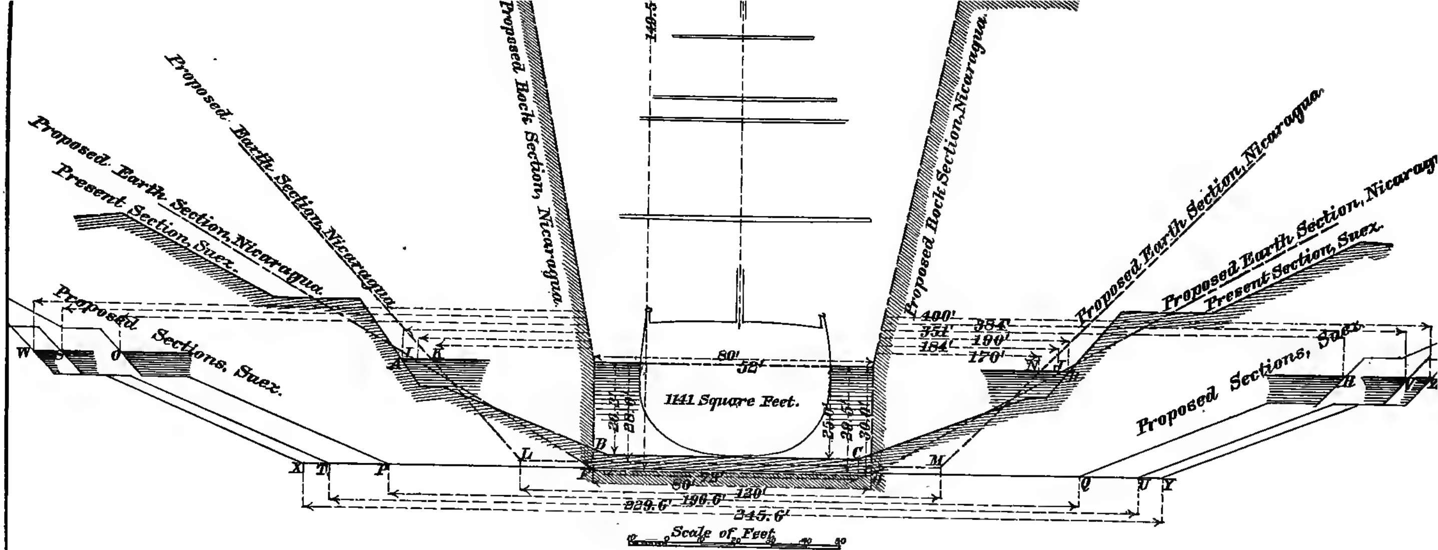
About three years ago Dr. Cardenas, the then president-elect of Nicaragua, requested the writer to submit a proposition for making the surveys and plans for the improvement of the San Juan river and harbor, giving as a reason that the government of Nicaragua had become convinced that nothing could be expected of the company represented by Mr. Menocal. Studies of the harbor of Greytown convinced the writer that it was irretrievably ruined, and that it was a very doubful, if not impracticable, task to permanently improve it. The writer mentions this simply to show that he has had special as well as general reasons for ascertaining the natural conditions existing at Nicaragua. The knowledge the writer is charged by the Admiral with having, but not using, is no doubt that of the plans from time to time promulgated by Mr. Menocal, who, with some other but higher officials of the United States Government, has devoted much of his time to this scheme for several years. Their various surveys and plans, however, have not in any way modified the natural conditions existing at the Isthmus of Nicaragua, and Mr. Menocal and Admiral Ammen must not feel hurt if the writer and others use their judgment in selecting the plans and estimates which appear to them to be most reasonable and best considered. It is not to be expected that any one can acquire full knowledge of the various plans, surveys, and estimates which Admiral Ammen is in the habit of making of the Nicaragua Canal route. The plans of Mr. Menocal should not be considered final, if for no other reason than that they are periodically undergoing very important modifications. The examination of the plans which he now brings forward shows how far from a state of perfection, and how poorly adapted they are to accomplish the work for which the former plans were found by Admiral Ammen and Mr. Menocal to be unfitted.

It was recently ascertained that the canal planned in 1872–1873, and essentially the one laid before Congress with the treaty last winter, would not accommodate either the ships or the traffic expected. The new plans now promulgated are intended to correct these important omissions in the earlier plans and to provide, it is said, an adequate channel for ships of 52 feet beam and for a traffic of 12,000,000 tons per annum, and an ultimate traffic of 20,000,000 tons. Though the dimensions are much greater and the prices larger, the detailed *cost of the canal is less.* This happy result has been obtained by a hasty survey made through a densely wooded country, " over ground alternately swampy and hilly, and covered with a dense vegetation, through which every foot of the trail had to be cut with a machette, and where travelling was fatiguing in the extreme, officers and men being compelled in many instances to go long distances buried to the waist in the mud and water, with a very uncertain bottom to stand upon." (See synopsis of Engineer Menocal's report of recent date.)

When this hasty and very preliminary work is compared with the surveys of the Tehuantepec Isthmus for the Ship Railway, occupying nearly *two years*, the greater reliability and accuracy of the latter stand out prominently. It seems proper to the writer to still rely upon the estimate made by Major McFarland for the construction of the Nicaragua Canal, for the reason that it appears to him to be the best considered. Only one exception can be taken to it, in the writer's opinion, and that is in the price of labor, which was estimated at $1.00 per day. This, by recent developments on the Panama Canal, has been shown to be too low. The writer is informed by Mr. C. Colné, general agent (in this country) of the Panama Canal, that the average cost of labor employed by the Canal Company is $2.00 per day. As Major McFarland's estimate of the Nicaragua Canal was $140,000,000, it does not seem unreasonable to place the cost at present at $200,000,000 if we double the cost of the labor.

INADEQUACY OF THE NICARAGUA CANAL.

Let us see if the Nicaragua Canal as now designed by Mr. Menocal will accommodate a traffic of 12,000,000 tons, which has to pass through rocky excavations and other dangerous navigations, and *not* through a channel excavated in sandy material like that of the Suez Canal. The accompanying sketch shows the cross-sections of the proposed Nicaragua Canal in earth and rock cuttings, the present sections of the Suez Canal, and those recommended for that Canal by the distinguished International Commission of Engineers which recently examined the question of its enlargement. A glance at the ship for which the Nicaragua Canal is intended, and the comparative sections, will show how utterly inadequate is this proposed canal. The impossibility, practically, of pushing a steamer or towing a sailing vessel through the seven miles of rock prism, whose dimensions are *eighty* feet at



SECTIONS OF THE SUEZ AND NICARAGUA CANALS.

Designation of Section.	Surface Width in Feet.	Bottom Width in Feet.	Depth in Feet.	Area of Prism in Square Ft.	Ratio of Canal Prism to Ship Section.
ABCD—Suez—Present—Rectilinear	190	72.0	26.2	3577.5	3.135
OPQR “ Enlargement “	351	198.6	29.5	8089.6	7.090
STUV “ “ Curves over 8200′ Radius	384	229.6	29.5	9063.1	7.943
WXYZ “ “ “ under “ “	400	245.6	29.5	9535.1	8.357
EFGH—Nicaragua—Rock cut	80	80.0	30.0	2400.0	2.103
IFGJ “ Earth “	184	80.0	30.0	3960.0	3.471
KLMN “ “ “	174	120.0	28.0	4116.0	3·607

bottom, and *eighty feet at the surface of the water, about the width of the Erie Canal,* is very plainly seen and appreciated. In Mr. Scott Russell's Naval Architecture, chapters xxxi and xxxii, appears the following, relating to vessels moving through canals :

> "The water excavated from the way of the ship causes a continual accumulation of water in the region of the canal towards which the ship is moving."......"If this wave travel ahead of the ship only one-fourth of the pace of the ship, the accumulation will be quadrupled; one-eighth will make it eightfold, and so on, until the progress of the ship becomes extremely difficult, or impossible. This is what constantly takes place as the rise of the ship, and the pace in a narrow and shallow channel becomes greater. Practically, working at high speed becomes not difficult or costly, but impracticable."......"The consequences of this rapid increase of head accumulation, which takes place as the speed of the wave in advance of the vessel diminishes, are very serious. First, it throws the ship's head up out of trim; next, it increases the pressure of water on her bow; third, it makes her travel up-hill; fourth, it produces a backward current along her sides. And these hindrances to speed accumulate rapidly, much more rapidly than as the square of the resistance, until the amount becomes insuperable; that is, many times the resistance due to the law of the square of the speed."......"It is now necessary to notice the complementary effect to that of accumulation in advance of the vessel; it is subsidence of water astern. It being known that the excavated water is sent on in advance of the vessel, it becomes plain that the channel out of which this water has been taken must have its height lowered by the subsidence of the water into the vacant channel out of which the ship has been drawn."

With these principles before us, and in view of the fact that this narrow prism of the canal covers a length of *seven miles,* the reader can form an accurate idea as to whether the ship will pass *safely* through the designed section in rock excavation at *any* speed, much less the speed of *five miles an hour,* as estimated by Mr. Menocal. Attention is also called to the ratio of the immersed section of the vessel to the water prism of the canal as shown in the table on the diagram of sections.

It is stated in Engineer Menocal's report that steamers can make eight miles an hour in the San Juan river. The width at the bottom in the first 28 miles from the lake is to be only 125 feet in many places, and the channel is often very tortuous. On the western division the same difficulty exists in certain parts of the crooked and narrow valley of the Rio Grande. A rate of speed over three or four miles an hour in these tortuous and restricted river channels would be a dangerous one. It is extremely doubtful if the large sailing ships which now go around Cape Horn could be towed *through the canal at all.* It would be necessary for the tow boats to take them astern, which would make it extremely difficult to steer them through the restricted portions of the canal.

ESTIMATES OF THE CANAL NOT SUFFICIENT.

In reference to the cost of construction there is much to criticise. The upper reach of the San Juan river for twenty-four miles is to be dredged a mean depth of four feet. The plan of 1873 required the removal of 834,832 cubic yards of rock under water. Mr. Menocal estimates that the present plan requires the removal of only 398,613 cubic yards. Every constructive engineer of experience will testify that from twenty to forty per cent. more rock is usually excavated than is included in the neat section of the work when it is removed from below water. It will be fair to assume that, to remove this 398,613 cubic yards of rock under water, will require the removal of at least 500,000 yards. The price estimated is $5 per cubic yard. In the opinion of the writer this is too low. It has cost to remove submarine rock in New York harbor, where every facility is at hand, and all conditions are favorable, from $16.30 per cubic yard to $34.00. (See detailed report of Gen. Roy Stone, in the report of the Chief of Engineers on the Hell Gate Improvements.) On the Welland Canal the tenders for the removal of from 15,000 to 20,000 cubic yards of rock under water ranged from $9.90 to $40.00 per cubic yard. The work was done at the former figures, but the quantity removed to give a clear channel depth and width was 34,600 *cubic yards.* (See Engineering News, July 11, 1885, page 17.) Under the circumstances existing at the San Juan river, with labor much more expensive and less effective, with appliances difficult to obtain, and with work scattered over twenty-four miles, $15.00 per cubic yard is not too large a price for an estimate. The addition required to the estimate from this cause alone will therefore be $5,506,935.

The harbor at Greytown, heretofore referred to, is so fully discussed in Major McFarland's report that it is unnecessary to allude to it further, except to state that corroborative testimony is found in a paper by Professor Henry Mitchell on "The Terminal Points of the Nicaragua Canal," in the United States Coast Survey Report of 1874, and also in the report of the Committee of the National Academy of Sciences, 1866. Major McFarland's estimate for its improvement was $9,500,000. The estimate in 1873 was $2,822,630. Mr. Menocal's estimate *now* is $1,766,625, a difference of $7,733,375 between that of Major McFarland and that of Mr. Menocal.

The question of successfully improving the harbor at Greytown is one of vital importance to the canal. The problem to be solved is how to restore and maintain a harbor that has been completely ruined and practically obliterated by forces it is well nigh beyond the power of man to control. Natural causes have diverted from their former channel the waters of the lower San Juan, and turned them into the Colorado river, which debouches into the sea through Costa Rica. When it is borne in mind that our engineers have failed to deepen the channel into a single harbor along the whole sweep of our Atlantic and Gulf coasts, except the mouth of the Mississippi, the folly is apparent of intrusting to an amateur the design and estimates for a work as difficult as that at Greytown.

Not only in this country, but also in Europe, has the improvement of harbors taxed the skill of the ablest hydraulic engineers for years, and immense sums have been expended by them in improving or constructing harbors under conditions much less complicated than those at Greytown. One of the most difficult problems ever presented in hydraulic engineering is the construction of a deep and safe harbor on a sandy beach exposed, like that at Greytown, to the severest storms of the sea. Yet a young engineer, of very limited experience, has been intrusted with this grave problem, and the result of his hasty studies and his periodical plans and estimates for this immense canal and its harbors occupied for months the serious attention of statesmen, committees, and senates.

There are several questionable and entirely novel methods proposed for the Nicaragua Canal which need examination by *experienced* engineers before they are pronounced practicable. As an instance may be mentioned a lock with 53 *feet* lift by the ordinary process. 30 feet is the greatest lift on any constructed canal, and that on the small Lehigh Canal. The tail-gate of the lock of 53-*feet lift*, 88 *feet in height*, is said to be of " novel design." We should think so !

The impounded waters of the San Francisco river are to be held back by a dam over 6,000 feet long and 51 feet in height.

The most radical and objectionable feature of the canal plans is, however, the general disturbance of the regimen of the rivers and the drainage of both slopes. Rivers are taken out of their natural beds, from the valleys in which they have run for all time, and are turned into artificial channels and in entirely new directions. The Rio Grande on the Pacific side, a mountain stream, and at times a torrent, is diverted from the Pacific towards the Atlantic, that is, into Lake Nicaragua.

The following from the official synopsis of Mr. Menocal's recent report is an illustration of the apparent ease with which the new regimen, in another instance, is to be established :

> "At this point the Deseado will be diverted by a channel north of the canal a distance of 43,000 ft. (8 miles;) the latter will be protected on both sides by drainage channels formed partly by the present bed of the stream and partly by ditches. The remainder of the canal, also about 43,000 ft., from the Deseado to the sea, will be protected by embankments, an artificial channel being cut south of the canal to divert the river San Juanillo, and another north of the canal to give Laguna Bernard and its tributaries an independent outlet to the sea."

Other river beds are to be dried up to give room for the canal, and their torrents are to be turned in any direction, and by any means, necessary to give the canal free "right of way." These streams are to be carried long distances apart from the canal, either inside embankments or in channels excavated in earth or rock. The general contour lines of the country do not impede the plan at all, and it may be said that the whole drainage system of the Isthmus is entirely and most conveniently rearranged. Three months' time was sufficient to make surveys that entirely modify all previous plans, and practically remodel the Isthmus, although it required with other extraordinary changes, deep rock excavations, one of which for about *three miles* in length, has an average depth of 149½ ft., and a maximum depth of 204 ft., and another a maximum depth of 318 ft., almost rivalling the famous Culebra cut of the Panama Canal.

One important object of Mr. Menocal's recent survey, as has been stated, was to find a location and natural conditions that would permit enlargement of the previous dimensions, so as to transport, *unimpeded, a traffic of* 12,000,000 *tons,* for "the Suez Canal is *unable to accommodate a traffic of more than* 6,000,000 *tons per year, without serious delays to navigation, owing to its dimensions* and insufficient number of turnouts." (American Engineer, November 26, 1885, presumably written by Mr. Menocal.) Practically the same is stated in the official synopsis of his recent report to Congress: "The apparent insufficiency of the Suez Canal to accommodate a traffic of more than 6,000,000 tons a year, without serious delay to navigation due to its reduced sectional area and the inadequate number of its turnouts, shows that the dimensions proposed in the previous reports for a canal across Nicaragua should be considerably enlarged." The above statement is correct, as far as the Suez Canal is concerned, and it was to remedy this very serious evil that the International Commission was called together. They decided that certain dimensions were necessary to accommodate the present traffic. The Nicaragua Canal dimensions are intended to accommodate a traffic *twice as great*, and the impression is conveyed in the official report that the plans *have been made with this special object in view.* "The constant object has been to provide for a canal which should permit the passage of the largest ships now engaged in the commerce of the world, and a traffic of no less than 12,000,000 tons per year, without restriction, rather than, for the sake of economy in first cost, propose what experience at Suez has proved to be inadequate." (See American Engineer, Nov. 26, 1885, page 227.) The cross-sections (see sketch, page 19) show that, in a distance of 37.6 miles of excavated canal, (the total length being 38.98 miles,) the dimensions now proposed by Mr. Menocal *must be enlarged one hundred and fifty per cent.* to make them as large as those decided upon for the Suez Canal to accommodate a traffic *fifty per cent. less* than that assumed to have been provided for by the Nicaragua Canal plans. The average of three sections proposed for the *Nicaragua* Canal gives an area of 3,492 square feet. The paper read before the Austrian Society gives the section of the Suez Canal as 3,956 square feet. The average of the proposed enlargements of the Suez Canal is 8,576.3 square feet. (For details, see the table on sketch, page 19.) As this 37.6 miles of the Nicaragua Canal comprises the most expensive part of the work, it seems fair to increase the cost proportionately if we are to modify the estimate to produce an *adequate* section. The estimated cost of this part of the work as at present designed is $28,546,542. The cost of the same on the basis of the Suez Canal enlarged section is $42,819,782, at Mr. Menocal's prices. If the channel in the San Juan river and the nine miles of excavated channel in Lake Nicaragua are enlarged from 125 feet bottom width in the first case, and 150 feet in the second, to that of the Suez Canal enlargement, which is 224 feet, the increased cost in the first case will be $3,530,453, and in the second case, $189,760. To make a harbor at Brito will cost, as estimated by Major McFarland, $5,000,000. Mr. Menocal's estimate is $1,611,500, or $3,388,500 *less*. As all who have examined it call it a "harbor only by courtesy," and as no essential change has occurred there in the last twelve years, to the writer's knowledge, it is judicious to assume that Major McFarland's estimate is quite as reliable as that of Mr. Menocal. Summing up the several additions to the estimate, and adding 25 per cent. for contingencies—which has been added by Mr. Menocal to his estimate—we have a total *increase* of $88,960,898. The total estimate as given by Mr. Menocal is $64,043,699. The total revised estimate is therefore $153,004,597.

The very expensive work, as it certainly will be found to be, of modifying the whole drainage system of the Isthmus, and providing adequate channels to carry to the sea the floods of an annual rainfall of 102 inches without danger to the canal, have not been touched upon in this review, for the reason that the topography of the country and the detailed plans and estimates are not available. It should also be noticed that Major McFarland's estimate was based on a canal whose average sectional area was 2,309 square feet only, while Mr. Menocal's area is 3,409.2 square feet, about *fifty per cent.* greater than Major McFarland's. If we assume that it would require an addition of 40 per cent. to build the canal *according to Mr. Menocal's sections,* the total cost, then, on Major McFarland's basis would be $189,500,000, and, to build it according to the Suez Canal enlarged dimensions $264,500,000.

Mr. Menocal, who was hastily despatched to the Isthmus last winter without authority from or appropriation by Congress, had a serious work to accomplish in a very inadequate time. It was actually necessary to design a *larger* canal and find a location for it so favorable that the cost would not exceed the estimate of the canal whose plans were then before the Senate. How fully he accomplished *this* part of his task is seen by placing the two estimates side by side: The estimate before the Senate was $65,722,147; the present estimate is $64,043,699, or $1,678,448 *less*, while the canal is *fifty per cent. larger*. Whether the plans and estimates can be made satisfactory to intelligent men is exceedingly doubtful. It cannot be successfully denied that the section now designed *does not give the free and unrestricted waterway* that is *absolutely necessary* to make it favorably compare with a ship railway as a means of transportation, and that it does not *at all compare* with the adopted dimensions of the Suez Canal enlargement, and does not in *any sense* overcome the *very serious embarrassments* under which the Suez Canal labors at present.

PERSONAL ASSAULT UPON MR. EADS.

In an address before the American Association for the Advancement of Science, the writer took occasion to refer to the great works accomplished by Mr. Eads, and to speak of his acknowledged ability as an engineer.

This passage has greatly disturbed Admiral Ammen, and he occupies *six* pages of his pamphlet in personal abuse of Mr. Eads and detractions of the various important works that he has accomplished. According to the Admiral all of these works are failures. The 14 ironclads which he designed and built with such marvellous celerity were but poor affairs and rendered no real service; the bridge across the Mississippi at St. Louis, pronounced by the British Encyclopædia to be the finest specimen of arch construction in the world, is a flimsy structure, likely at any moment to fall into the stream; and the jetties at the mouth of the Mississippi river will soon be choked up with sand. The motives which prompt this personal attack upon Mr. Eads are so apparent as to excite for their vindictive author a mingled feeling of pity and regret.

Not only does Admiral Ammen assail the works of Mr. Eads, but he even goes so far as to attack his personal character. That character needs no defence, especially against one who strives to defeat an enterprise of immense public utility, by the personal abuse of its projector, and the revival of stale and refuted slanders against him.

To mislead the public regarding the personal relations existing between General Grant and Mr. Eads, (which up to the day of General Grant's death were of the most friendly character,) Admiral Ammen publishes in his pamphlet an extract of a letter written by the General in 1882, to Mr. Eads, in reference to the Ship Railway Bill then pending in Congress. This letter embodied several of the misrepresentations published at the time by the Admiral and Captain Phelps to defeat that bill, and was written under the evident impression that their interpretation of the bill was correct. Under this view he deemed it proper to write to Mr. Eads that he should oppose the bill, because he had previously given him to understand that he would not do so. At the same time he sent a copy of this letter to Senator Miller, of California, who had charge of the Nicaragua Canal bill, and who was a decided advocate of that measure. On receipt of the letter Mr. Eads at once sent a reply by the General's son, Mr. Jesse R. Grant, pointing out to General Grant the misapprehension under which he was laboring. Within two days after the date of this reply, J. R. Grant wrote and telegraphed Mr. Eads that his letter was satisfactory; *that a copy of it was sent to Miller, and that the General had written to him, Miller, explaining the error he had made.* General Grant therefore had sent the copy of Mr. Eads' letter and *his own admission of his error* to Senator Miller *immediately* after receipt of Mr. Eads' letter, for the evident purpose of correcting the wrong impression which his letter to Mr. Eads would naturally produce in the mind of that Senator. General Grant soon after wrote to Mr. Eads *reassuring* him that he would put no obstacle in the way of the passage of the Ship Railway bill. That Admiral Ammen should be supplied with a copy of General Grant's letter to Mr. Eads, by either Grant or Miller, without learning from one or the other anything about Mr. Eads' reply to General Grant or the copy of it sent to Miller and his subsequent and immediate admission to Miller by letter that he was in error, is simply incredible. It follows therefore that Admiral Ammen has been making a most discreditable use of General Grant's letter, and one that must be condemned by every fair minded man who will read that letter and Mr. Eads' reply. Both of these will be found in the appendix to this review with collateral facts relating to this part of Ammen's personal assault upon Mr. Eads. His suppression of these facts proves that he is willing to place his deceased friend and benefactor in a false position before the public, to gratify his hate of Mr. Eads for wrecking his pet scheme on which he had doubtless based his hopes of a colossal fortune and an imperishable fame. One of the noblest characteristics of General Grant was his readiness to admit an error at once when convinced that he had made one. A notable instance of this manly virtue is shown by him in this correspondence, and the suppression of all reference to it by Admiral Ammen places the characters of the two men in strong contrast.

As Admiral Ammen has chosen to criticise Mr. Eads' professional abilities and to ridicule and belittle the high expert testimony we have adduced in favor of the Ship Railway, the writer will be pardoned for answering the natural inquiry: "Upon what meat doth this our Cæsar feed, that he is grown so great?" We find that at the age of 41, when the late war broke out, he was a lieutenant in the navy in command of the gunboat Seneca, which he assures us was not fit to be carried across the Isthmus on a carefully prepared railway. If he ever commanded a fleet for a day, history has failed to record it. Certain it is that his services during the whole war were not sufficiently important to secure his promotion to a captaincy. This tardy recognition of his abilities came in 1866. Tradition has it that he had saved Grant from drowning when they were boys together, and Grant was not made of the stuff to forget such a favor. When he came into power Captain Ammen fared better. He was furnished with a good soft place as Chief of a Bureau in the Department, a comfortable salary, and the usual rations, perquisites, etc., and after decent delay he was made, in 1872, a Commodore, and finally, a Rear-Admiral.

With all due respect to the Admiral the writer fails to see, in the record of this officer, how he has become fitted by education, experience, or any notable success whatever, during his whole official career, (except in the way of promotion,) to make him an authority on hydraulic engineering, in the science of shipbuilding, or in the construction of railroads and lifting docks. With about half of his life spent as a midshipman and lieutenant on shipboard, and the remainder as a fixture in the Navy Department, he essays to ridicule and criticise the projector of the Ship Railway, and the most noted and successful experts in these various departments of civil engineering who gave their hearty endorsement to the Ship Railway.

The Admiral and his coadjutors place much stress on the fact that we have adduced no evidence from underwriters that they will insure a ship in transit on a ship railway. They forget that the railway company will be *a common carrier*, and will therefore be responsible for the safe delivery of every package (that is, each ship) it receives at one end of the line until it is delivered in good condition at the other end. Hence the insurance companies, during this part of the voyage, are relieved of all risk, (except perhaps that of fire,) and a company with a capital as big as twenty or more insurance companies becomes responsible for each vessel after it undertakes to transport it on its railway.

MR. MENOCAL'S WANT OF KNOWLEDGE AS TO TEHUANTEPEC.

The letter of Engineer Menocal incorporated in the pamphlet of Admiral Ammen shows such a lamentable want of knowledge of the Tehuantepec Isthmus and the Ship Railway location and plans, that it is scarcely necessary to weary the reader by the many flat denials needed to correct his misstatements. The most important of them we will, however, take up briefly. The larger part of his letter is based on the assumption, which we have already shown to be false, that there is "nothing but assertions and generalities to deal with" in reference to the natural conditions existing on the Isthmus.

CONTROVERTING STATEMENT OF MR. MARTIN VAN BROCKLIN.

A recent letter of Mr. Van Brocklin, taking issue with Admiral Ammen and Mr. Menocal in reference to the statements made by them, will confirm whatever the writer has said in reference to the favorable conditions existing at Tehuantepec for the construction of a ship railway.

"ONEIDA, N. Y., *Feb'y* 26, 1886.

"E. L. CORTHELL, Esq.:

"DEAR SIR: I have read the pamphlet entitled The 'Certainty of the Nicaragua Canal, contrasted with the Uncertainties of the Eads Ship Railway,' by Daniel Ammen.

"The first thing presented is a profile said to be from Barnard's survey. My knowledge of the topographical features of the Isthmus of Tehuantepec, gained in making surveys at intervals from 1859 to 1883, enables me to say that a line *can* be traced across that Isthmus that will give a profile as irregular in surface as the one furnished, and further, that should it suit the purpose of a supposed investigator, a line showing *greater* irregularity of surface can, I think, be obtained. What a profile of the line surveyed by Barnard has to do with the line located for the Ship Railway is inconceivable. It seems incredible that a person of the prominence of Rear-Admiral Ammen would undertake to seriously discuss so important a problem as the practicability of the construction of a railway for the transportation of ships across the Isthmus of Tehuantepec, while so lamentably ignorant of the physical conditions existing on the line located for it, and of the difficulties to be encountered in its construction, as the pamphlet demonstrates him to be. He should have known that you had a complete detailed survey of the route including surveys for the improvement of the harbor on each side, (see page 18 of the publication of yours he quotes,) and a profile of the line indicated, giving full details of the work to be done, and yet for a purpose best known to himself he presents data obtained from Barnard's survey made in 1851, in another locality, and for an entirely different purpose, and also from a preliminary examination, by Mr. Garay, of a pass through the main divide, 10 miles distant from the line finally selected.

" The 'forty miles of swamp-land, more or less, from Minatitlan towards the Pacific,' that forms the basis for his *argument* of the 'Farmer,' and the 'Marine ram,' is a fiction, so far as its application to the Ship Railway is concerned; it describes no part of the ground upon which that work will be built. At every place on the line of the Railway, from the river bank at Minatitlan to the harbor on the Pacific side, the Railway will rest upon firm, unyielding material, possessing ample resistance to sustain any weight that will be placed upon it. There is an aggregate distance of perhaps eight miles, but dispersed in sections over the first thirty miles from Minatitlan, where the surface is covered with water during freshets in the Coatzacoalcos river, but these places cannot be called 'swamp-land,' as the material is a firm tenacious clay, and where not covered by a dense undergrowth, they afford valuable grazing ground for the large herds of cattle found in that locality.

" In the appended letter from Mr. Menocal it is demonstrated, evidently to his own satisfaction, that a vessel 300 feet long, and having a draught of 22 feet, will be exposed to an overturning moment of 4,000 foot tons, from the force of winds alleged to be prevalent at Tarifa during certain seasons. The authority quoted in the pamphlet shows conclusively why such winds as do cross the Isthmus are confined to a given direction; the same reasons give a similar direction to the railway, and just how Mr. Menocal is to apply the force of the wind to the side of the vessel is not apparent. Evidently the people living at Tarifa are unmindful of the dangers to which they are exposed, as shown by Mr. Menocal's figures.

" The buildings of the hacienda of Tarifa stand in the open plain, and are exposed to the full strength of such winds as cross the Isthmus at that place. These buildings are covered with palm, and are, most of them, of very frail construction. The roofs are usually much larger than the walls of the house under them, extending far enough to give a broad veranda on each side. The theoretical wind of Menocal would demolish such frail structures. The fact that they stand uninjured, at Tarifa, and at all places on the Isthmus as well, is evidence that the actual force exerted by winds will not be a serious obstacle in the operation of the Ship Railway.

" Very truly,

" M. VAN BROCKLIN."

The following letter from Mr. Deming J. Thayer, a civil engineer of large experience, furnishes additional confirmation of the thoroughness of the surveys for the Ship Railway and of the favorable conditions existing at the Tehuantepec Isthmus.

"NEWTON. KANSAS, *March* 6, 1886.

"E. L. CORTHELL, Esq.,
"*Ch'f Engr. Tehuantepec Ship Ry., Washington, D. C.:*

"DEAR SIR: Rear-Admiral Ammen and Señor Menocal show, in their writings contained in the pamphlet recently published by the former, entitled, "Certainties of the Nicaragua Canal Contrasted with the Uncertainties of the Eads Ship Railway," a deplorable ignorance of the work done and results obtained by the engineers in the employ of the Ship Railway Company. The following corrections of some of their errors and information for 'seekers after truth,' I take pleasure in placing in your hands.

"From March, 1883, to July, 1884, from five to seven engineering parties fully equipped for the work they were to undertake were constantly in the field between Coatzacoalcos and the Pacific Ocean. The first six months in charge of Mr. Martin Van Brocklin, resident engineer, and the latter months under the direct supervision of the writer.

"We surveyed in an exceptionally thorough manner a continuous line from Minatitlan to the Pacific Ocean at Salina Cruz, that had no *marsh or swamp-land on any part of it*, no *grade* exceeding 52.8 feet per mile, or a curve of less than twenty miles radius.

"Later, we made lateral explorations, and exhausted practically the possibilities for improving the line, and obtained, as a result, the present location. Our lines were traced with the greatest care, check levels were run over the entire route, and especial attention was given to the extensive lateral topographical lines locating all streams and ridges of any prominence in the section of the Isthmus where any possibility existed of its being desired to trace a survey later. Maps, profiles, and reports of the work done, duly revised and certified to by the engineers in charge, were sent to you as frequently as possible, and I presume are in your possession at present for the information of 'seekers after truth' as well as for the needs of the Company.

"The hydrographic work accomplished was important. The Coatzacolcos river had its banks carefully located by transit lines from the initial point of the railway line above Minatitlan to the mouth of the river; and a detailed survey was made of the bed of the river. A large force of men was employed several weeks in this work alone.

"On the Pacific coast, the Upper and Lower Lagoons were thoroughly sounded, not as on previous occasions on given lines and at stated intervals, but extensively, and each sounding located from angles from carefully measured base lines on their shores.

" Borings were made to ascertain the material forming the bottom of the Lagoon in all important localities. In the Lower Lagoon, in a previously unexplored portion we discovered a basin only separated from the ocean by a sand-spit a couple of miles wide, which was two miles in diameter and had a uniform minimum depth of 22 feet, with a clean sand bottom. This basin is protected on the north by a rugged spur of mountains and is entirely land-locked; it will make, with little relative expense, one of the finest harbors in the world.

" Maps of all these surveys, as well as of the harbors of Salina Cruz and Bar of Coatzacoalcos are in your possession.

" In regard to 'marshy and swampy' ground, which our cited pamphlet lays such stress upon as covering a great portion of our line, let me say that in the lower Coatzacoalcos Valley, near Minatitlan, in the most unfavorable localities we could select, soundings with an apparatus made of gas pipe with a steel point to be driven down with blows showed that there exists everywhere, as a foundation for masonry, near the surface of the ground impenetrable strata of sand, gravel, or hard-pan; there was no exception to this rule; the upper over lying soil was a stiff clayey alluvion entirely suitable for the foundation of embankments.

" The force and effect of the 'northers,' in my opinion has been greatly exaggerated; they blow steadily, are not shifty, nor do they blow in gusts. There exist in no part of the world more flimsy structures than the country houses on the Isthmus of Tehuantepec, and they are loosely thatched with palm leaf or grass thatch.

" I have never seen one blown down, or its roof blown off or damaged in any way by a 'norther.' I have stood on a bare mountain summit on the divide near Tarifa and faced the whole force of one of the strongest winds of this kind ever known there. I could not have stood up in it had its force been any where near 40 lbs. to the square foot, (over 90 miles an hour,) as Señor Menocal estimates. It would have blown me to the plains a thousand feet below.

" Very truly yours,

" D. J. THAYER."

Mr. Menocal has given reports from the statements of three prominent engineers, one of them, Mr. Garay, a prominent Mexican engineer—

" Who located the line for the road across the mountain ridges for a distance of forty miles." * * * " The line run by him crosses the range of mountains, the deepest proposed cutting being 312 feet. He adds that in all the line there is no grade greater than two per cent., and for no greater distance than two and a half miles."

(See page 24 of Admiral Ammen's pamphlet.) The line surveyed by Mr. Garay is *not* the "*located*" line of the railway. It was a preliminary or trial line, surveyed to ascertain if an economical line with low grades could be obtained through the Chivela Pass. The located line runs through the Tarifa Pass, 10 *miles distant*. Mr. Menocal states that Mr. Fuertes, who was the engineer on the survey of the Ship Canal route under Admiral Shufeldt, confirms this statement of Mr. Garay by his report on the Ship Canal. The reader will see how entirely unfair is a comparison of a *ship canal* route with a *ship railway* route. Professor Fuertes himself has made a statement in regard to the practicability of building a ship railway across the Isthmus of Tehuantepec, based upon his own observations there, and from this statement the following quotation is made:

> "I can assure you, upon knowledge of every inch of the ground, that you will find no difficulty about curves, grades, or bridges. The ascent of the Atlantic slope will offer no more difficulties than the Hudson River R. R.; and, on the Pacific side, either one of the three passes in the neighborhood of Tarifa or Chivela will require no steeper grade than 25 to 35 feet per mile, to bring you down to the Pacific plains."

The above is quoted from testimony given to Congress three years ago, and which Mr. Menocal has knowledge of.

Mr. Menocal refers also to another engineer, Mr. William J. MacAlpine, who says:

> "I have described from *personal* surveys the route which his (Eads') engineer has selected, and have spoken of the enormous cost and difficulty of carrying his railway across the deep swamps of one-half, at least, of the first sixty miles from near Minatitlan, of the south descent of the Sierra Madre slope, (500 feet in four miles.)"

Mr. MacAlpine had no knowledge of the line selected. It had not been surveyed at that time. His remarks refer to the line run by Mr. Garay, already alluded to.

Mr. Menocal makes several misstatements in describing the mechanical appliances of the Ship Railway. He states that "the construction and operation of cradles weighing

1,000 tons or more, composed of an infinite number of parts, each of which must be accurately adjusted to sustain its part of the load, with pumps, engines, and rams." Mr. Menocal does not understand at all the plans he is criticising. The cradle will be a remarkably simple structure, composed of duplicated parts, which do not require adjustment, and there are *not to be on, or in, the cradle any pumps, engines, or rams.* They are fixtures in the dock.

INACCURATE STATEMENT OF MENOCAL ABOUT OTHER SHIP CANALS.

Mr. Menocal attempts to prove that the tendency toward larger canals and greater loads exists upon canals as well as upon railways. This no doubt, in a measure, is true, as it is one of the necessities of the times, but enlargements and improvements to meet the requirements of traffic are very difficult and expensive upon canals, and rarely made. He states :

> "Are not the Caledonia, the Amsterdam, the Languedoc, the Welland, the St. Mary's Falls, the Suez, and many other canals now in successful operation, and being constantly enlarged and improved to meet the rapidly increasing traffic, and those under construction or about to be constructed at Panama, Manchester, Cape Cod, Corinth, Baltic, &c., improvements on the canals referred to by Mr. Corthell?"

This statement presents a strong array of what the reader would naturally suppose were all large modern ship canals, or being constantly enlarged, and with capacious channels. The facts are these : The natural features of the country along the line of the Caledonia Canal across Scotland are quite similar to those existing at Nicaragua. Its summit is 100 feet above the level of the sea. It is 60 miles long, 38 miles being through lakes. It was built early in this century, before the era of railroads, and has a capacity for vessels of *only* 300 *tons.* Mr. Vernon-Harcourt, in his book on canals, states : "Regarded merely as an engineering work, the canal was a bold and successful undertaking, very judiciously planned and successfully carried out; but it has not proved a commercial success."

The Amsterdam Canal, if Mr. Menocal refers to the new canal, is a short deep channel from the Baltic Sea to the Zuider Zee, and has but one lock in its length of 15½ miles, and was excavated through lands reclaimed from the sea. It was an absolute necessity to Amsterdam. The Languedoc is an ordinary Barge Canal, and *not* a Ship Canal, extending from the Bay of Biscay across France to the Mediterranean Sea. It was built in 1667, is 171 miles long, and has a depth of *only* 5 *feet and* 3 *inches.* It *has not been enlarged,* and is of merely local value. The Welland Canal, although intended to be of sufficient depth to accommodate the traffic of the great lakes, and take the grain to Montreal, has been found to be entirely inadequate, as there is a depth of only 14 feet in the locks. This mistake is almost irreparable, and an adequate enlargement cannot be made, except at great expense.

In reference to the Suez, once more, which is by far the most important ship canal in the world, the expense of deepening and widening it for even its present navigation is estimated at 200,000,000 francs, or $40,000,000, by the distinguished International Commission. This estimate is the same as that given by a former International Commission for the *original construction of this canal.*

The Manchester Ship Canal, although approved by Parliament, has not yet been commenced. The Cape Cod Canal has been in embryo for 219 years, and has been scarcely commenced, work upon it being now suspended. The Corinth Canal is almost over the same ground where the Athenians, 550 years B. C., built the "Dioclus," a *veritable ship railway* of polished granite, which they operated for 300 years. Had the Greek of the present day the skill and energy of the ancient Athenian, his great ancestor, he would have constructed a *new and improved ship railway*, *instead of digging a ditch.* The Baltic Canal, also alluded to by Mr. Menocal, *has not been decided upon*, and recent information shows that it has only just been presented for the consideration of the Reichstag. This short paragraph, therefore, of Mr. Menocal in reference to these important ship canals needs to be supplemented by these facts to show how little weight it possesses.

CAPACITY OF THE SHIP RAILWAY.

The ultimate capacity of the Ship Railway is practically unlimited. It is the intention of its projectors to construct it at the outset for vessels weighing with their cargoes 7,000 tons. There are less than a dozen steamers registered under the American flag that have a greater load displacement than 6,000, and there are no sailing vessels of greater weight. There are no war vessels, either now in the service or contemplated, whose weight with armament, coal, and supplies on board, will exceed 6,000 tons.

The bill now before Congress requires the transportation of vessels, weighing with their cargoes at least 6,000 tons, as a test of its practicability, and 7,000 tons after the first year. This, however, does not represent its full capacity after the roadway has become well compacted and settled. It is also the intention to so prepare the foundations and excavations that the railway may at any time be enlarged to transport still larger vessels, when commerce demands it.

One great advantage of the railway over the canal lies in the fact that it can be easily and inexpensively enlarged for an increasing traffic and tonnage without interruption to its regular business.

The facts stated publicly by the writer during the last two years going to show the marked superiority of railroads over canals, and ship railways over ship canals, have not been refuted. These facts are drawn from the history of transportation in various countries during the last sixty years.

From the discussion of the Nicaragua Canal in the preceding pages it has been seen that the disadvantages of the ordinary barge canal exist in a still greater degree with such a ship canal as has been proposed for Nicaragua. The advantages, however, of the ordinary railway are greatly enhanced in the ship railway. These increased advantages arise from the following conditions: the rails are straight, the track perfect, the grades light, larger loads are carried, the ratio of paying to non-paying loads is greater, the frictional resistance to the motive power is reduced, the speed is slower and less destructive both to the track and the rolling-stock. One of the most important advantages lies in the fact that it will not be necessary to handle the goods. This is one great source of the expense of operating ordinary railways, and it is generally considered that it costs as much to handle a ton of freight as it does to transport it 100 miles. The immense clerical force employed on ordinary railroads will be almost entirely dispensed with on the Ship Railway.

Comparing the Ship Railway with the Nicaragua Canal, the following are the advantages of the former. The road-bed of the railway is *above the water* and is not subject to the effects of the dangerous floods, or the immense slides from excavations; the road-bed to be maintained is of much less width than the prism of the canal, and the material required is handled with less expense. The enormous expense of maintaining a ship canal on the American Isthmus is evidenced by the estimate of Mr. De Lesseps, that it will cost $7,000,000 per annum to maintain the Panama Canal. The cost of towing vessels or propelling steamers through the canal is considerably greater than their transportation on the railway.

THE SUPERIOR ADVANTAGES OF THE TEHUANTEPEC ROUTE.

The distance in an air-line from the mouth of the Coatzacoalcos river, the terminus of the Ship Railway, to Greytown, the terminus of the Nicaragua Canal, is as great as the distance from the mouth of the Coatzacoalcos to New Orleans, or from New York to Jacksonville, Florida, or St. Louis, or Cape Breton. These comparative distances show how immensely superior is the location of the Ship Railway to that of the Nicaragua Canal, especially between all our Gulf and Pacific ports, as this distance of 800 miles must be nearly doubled. This distance and the time required, added to the long time required to pass through the Nicaragua Canal, shows the immense advantage of the railway in these respects.

Another advantage, not to be lightly considered, is the defensibility of the Tehuantepec route. Both harbors are landlocked ; both are easily capable of defence by fortifications ; both can be reached quickly by railroads traversing the Republic of Mexico ; the straits of Yucatan and Florida can be easily defended by our Navy, and we may depend upon the assistance of the strong neighboring republic in whose territory the Ship Railway lies, and we may also rely upon her encouragement and assistance in promoting in every possible way this interoceanic transit-way.

CORRESPONDENCE

BETWEEN

GENERAL U. S. GRANT AND MR. JAS. B. EADS,

WITH A

REVIEW OF THE SAME BY MR. EADS,

SHOWING THE PERVERSION AND UNWARRANTED USE OF THE CORRESPONDENCE BY ADMIRAL AMMEN.

See Page 29.

[*From the New York Herald, March 5th, 1886.*]

MEXICAN SOUTHERN RAILROAD COMPANY,
NEW YORK, *Jan.* 13, 1882.

Captain J. B. EADS, *Washington, D. C.:*

DEAR CAPTAIN: Until I met you in the city of Mexico and had conversations with you there, and subsequently, on the subject of your Interoceanic Ship Railroad and read some of your pamphlets upon the subject, I had thought that I saw insurmountable obstacles in the way of the success of your enterprise. You so far removed my doubts about the practicability of carrying ships with cargoes securely by rail, that, while I was not sanguine that it would prove a success, I yet was not prepared to say that it might not be.

I am of that opinion still, but at the same time you gave me to understand that no guarantee was to be asked from the Government until a section of ten miles of the railroad was built, and had carried a vessel of the capacity of 2,000 tons burden to the terminus at the rate of ten miles an hour and returned at the same rate of speed, and had landed the vessel safely in water, when the Government was to guarantee three per cent. interest upon $5,000,000. Upon the completion of a second ten miles of the railroad a vessel of 2,500 tons burden, with her cargo, was to be transported to the terminus at the rate of ten miles an hour, and again returned to the water at like speed, without injury, when a second instalment of $5,000,000 of bonds were to be guaranteed for a like interest and on the same conditions. At the completion of each section for ten miles the like test was to be applied with vessels, increasing 500 tons with each section, until one with her cargo of 4,000 tons should be transported to the terminus of the road and into the water; and on completion and the success of each section of ten miles the like interest on $5,000,000 of bonds were to be guaranteed by the Government until the whole amount should reach $50,000,000.

I have felt a very great interest in the matter of communication between the Atlantic and Pacific oceans somewhere in North America, and which should be mainly under the control of the United States Government and United States capital. To that end, with the valuable aid of Admiral Ammen, I had succeeded in having all of the well known lines of low level between the United States of Columbia in South America and Tehuantepec surveyed, and had submitted the result of the surveys to a board of engineers, which I convened. That board, on an examination of these various reports, reported that no other route was practicable for a ship canal as compared with the Nicaragua route. From that time on I became interested in seeing that work undertaken by an American company, not caring who it was done by so that it was done, but willing to lend my name to the enterprise because there is no problem whatever as to the practicability of the route and no difficulty in doing the work if the capital can be secured for it.

But your proposed work accomplishing the object which I had in view, and seeming to have followers who might be willing to furnish the necessary capital, I was induced on your statements to say to Admiral Ammen and to Captain Phelps that with money appropriated for the De Lesseps canal, by the way of Panama, and the following you had for your road, it was idle for us to try to enlist capital in a third enterprise of this kind, and as you asked nothing from the government more than a guarantee that your road earned three per cent. upon fifty millions of capital, if it could carry vessels of 4,000 tons burden successfully from ocean to ocean and without injury to the ships, I thought the Government was running no risk whatever, and advised that we should let the matter drop until either the two enterprises under construction and in contemplation were exploded or proved a success. If yours should prove a success the Nicaragua Canal would not be wanted at all, at least not in the near future.

But I now have your bill—No. 430—before me, and see that its provisions are so entirely at variance from what I had been led to suppose you intended to ask that I feel it my duty to notify you that I shall oppose it in its present form with all my ability. I do this because I feel that I have been deceived as to what you intended to ask, and also believe that if your present bill passes the Government will be made responsible for six per cent. interest upon a large bonded indebtedness even if your enterprise should prove a total failure.

In the first instance the speed with which vessels were to be safely transported is changed by this bill from ten miles to six miles an hour; the rate of interest upon the bonds guaranteed is changed from three per cent. per annum to three per cent. semi-annually; the vessels transported of the named tonnage are to be vessels with their cargoes weighing the amount of what I supposed was to be the tonnage of the vessels. I do not think the change of ten miles to six per hour, or even to four, a serious objection; but the change in the class of vessels transported and in the rate of interest asked are very serious changes.

Then, also, in your bill you provide what I would approve of for using rivers and canals as far as it was practicable to do so, and to shorten the line of railroad simply to what would be necessary to get over the elevation dividing the two oceans. An examination of the map shows that by deepening the mouth of the Coatzacoalcos river six feet you have a navigable river for all the vessels you propose to carry for thirty miles. From thence to the foothills, through a flat and marshy country where the amount of excavation will be a minimum, you will have a still greater distance where a canal can be cheaply constructed. In like manner on the Pacific side, with a little deepening at the mouth of a slough or small lagoon, connecting with the Pacific, and by deepening between that and another lagoon inland, and a canal through a flat and low country to the foothills, in all a distance of twenty to thirty miles or more, ships of the classes you propose to carry can easily be transported. All this leaves the extent of ship railroad to be built probably less than one-fourth of the entire distance across from the Gulf of Mexico to the Pacific ocean.

Your bill provides that the same subsidy shall be guaranteed for water communication that is allowed to the railroads, and the same rate of speed, viz., six miles an hour, is not mandatory in the canal.

This would give you, by the terms of this bill, a guarantee of $5,000,000 for the first ten miles, which would be river navigation from the Gulf of Mexico, and a like sum for the first ten miles from the Pacific coast, likewise of water navigation, nearly completed by nature.

The balance of the route is to be divided up into twenty sections of equal length. Whenever any one of them is completed on either side bonds to the extent of $2,000,000 are to be guaranteed for each section as completed.

All this would insure to you or to the company that you represent a guarantee of from thirty to forty millions before it would be necessary to enter upon that portion of the work which is in any degree problematical—viz., the ship railroad. The Government is bound to provide for this six per cent. interest, whether the railway and canal earn it or not, for fifteen years after the completion of the road.

Now it looks to me very much as if that portion of the work about which there can be no difficulty might be completed, these thirty to forty millions of guaranteed bonds secured and the work stop entirely, and as it never would be completed, there would be a six per cent. irredeemable bond for which the Government would be responsible for the interest fastened upon it.

Now, I know, Captain, that you are enthusiastic and have full faith in the feasibility of the work you propose. I am satisfied, further, that if the matter was left entirely to you, you not only would spend every dollar that you could realize out of the bonds in proving the feasibility of your plans of transporting ships, but you would spend all the private means that you could in any way raise, by hypothecating the second mortgage bonds, or even your private estate.

But you must recollect that this is a company, will have directors, will be controlled by the capital that is put in it, and even if there was a possibility of the success of your enterprise by the expenditure of a large sum of money, the stock of this company might be held by men who would be satisfied with the thirty to forty millions they had already received and would oppose any further progress of the work or expenditure of the means, because at the expiration of fifteen years after the completion of the work the Government would cease to be responsible for either the principal or interest of these bonds.

I have felt it my duty to state these objections to you, because you had reason to understand that while I might do nothing to favor your project (because I was not entirely satisfied with its feasibility) I would not antagonize or oppose it. Now that I have concluded that I must oppose it, you should know it first.

I was somewhat surprised when I saw Senate bill No. 550, to incorporate the Maritime Canal Company of Nicaragua, was introduced. I supposed what I had said to Admiral Ammen and Captain Phelps would probably prevent anything being done in the way of inaugurating that company until, as I suggested before in this letter, the other enterprises for interoceanic ship communication had proved a failure, and my first impulse was to write to Senator Miller, stating frankly what I had said to these gentlemen, and what my ideas were on the subject; but fortunately I was so pressed for time for a few days after the bill was introduced that I could not take the matter up, and afterward forgot it, until I saw your bill, of which I am now speaking, and I confess to you I was very glad that I had not written the letter which I had contemplated writing, and I shall take the liberty of furnishing Senator Miller a copy of this letter.

Assuring you that I have no pride in the establishing of any particular line or route for the transportation of vessels between the two oceans, but only to see the work done, and do not care by whom it is done provided it is under American auspices, and that I should wish your enterprise the same success that I would if my own name was connected with it if inaugurated on terms that were not going to make the Government responsible for any failure.

I am very truly yours,

U. S. GRANT.

[The *Times-Democrat* of New Orleans published the following letter April 11th, 1886, as the *N. Y. Herald* refused to print it, although it had just given to the public the preceding letter of General Grant.]

THOMASVILLE, GA., *April* 3, 1886.

EDITOR OF THE NEW YORK HERALD:

DEAR SIR: During the last sixty days, a pamphlet entitled "The Certainty of the NICARAGUA CANAL Contrasted with the Uncertainties of the EADS SHIP RAILWAY, by Daniel Ammen," has been extensively circulated in Congress and throughout the country. This pamphlet is full of gross misstatements respecting the Ship Railway, which, on account of the high naval rank of its author, are calculated to gravely mislead the public. About six pages of it are devoted to such offensive personalities and billingsgate in relation to myself, as to forbid any controversy whatever on my part with its author. I only notice the pamphlet to correct the impression likely to be created by the following extract which it contains from a private letter addressed to me by General Grant on the 13th of January, 1882, relative to the Ship Railway bill then pending in Congress:

> "But I now have your bill—No. 430—before me, and see that its provisions are so entirely at variance from what I had been led to suppose you intended to ask, that I feel it my duty to notify you that I shall oppose it in its present form with all my ability. I do this because I feel that I have been deceived as to what you intended to ask, and also believe that if your present bill passes, the Government will be made responsible for six per cent. interest upon a large bonded indebtedness even if your enterprise should prove a total failure."

The purpose of Admiral Ammen in publishing the above is to create in the public mind the belief that I deceived General Grant in 1882, just as he is now endeavoring, by grossly distorting its provisions, to make the public believe that I am striving to deceive it with the present Ship Railway bill. This pamphlet states that this private letter will soon be published. Accordingly, on the 5th ultimo, it appeared in full in the New York *Herald*, and naturally elicited many unjust comments from other newspapers throughout the country. As you have given widespread currency to General Grant's letter, I beg space for this communication, which, owing to my recent illness, has been unavoidably delayed.

To enable the reader to know who deceived General Grant in this matter, it is necessary to state certain facts before submitting the reply made to his letter.

During the last twenty-two years of General Grant's life our friendship was of the most cordial character, a fact attested by his private letters to me, the last of which is dated May 13th, 1884, more than two years after the date of the one above referred to. During this period he gave many proofs of his great confidence in my judgment and abilities as an engineer. Within the last month I have received a letter from a distinguished Confederate officer, containing a reference to a conversation with Gen'l Grant on the subject of the Isthmus problem as late as 1885, during which he says Gen'l Grant declared that he considered Mr. Eads the very highest authority upon that subject in the world. During the last days of his administration I talked with him fully and freely upon the importance of a ship transit across the Isthmus, and told him that on the completion of the Jetties I intended to devote myself to its solution, as a legitimate supplement to that work, as it would virtually extend the Mississippi river into the Pacific. I referred to the immense benefit he could confer on his country and mankind by lending his great influence in accomplishing the proposed work. I expressed no preference at that time for any one of the routes, but suggested that his prominent identification with the enterprise would be a legitimate sequence to the deep interest he had shown during his official career in the Isthmian problem and in the opening of the Mississippi river. He expressed an earnest wish to aid the undertaking, and said that on his return from his contemplated tour around the world we should talk more definitely on the subject.

During Gen'l Grant's tour I took up the study of this problem and finding that the distance between the mouth of the Coatzocoalcos (the entrance to the Tehuantepec route) and Greytown (the entrance to the Nicaragua route) was as great in an air-line as the distance from New York to the Gulf of Mexico at Tallahassee, I saw at once the immense advantage in point of location possessed by Tehuantepec. I then satisfied myself that while a canal was not practicable at Tehuantepec, it was practicable to carry ships over that Isthmus by railway. Further studies satisfied me that their transportation by rail would be really more economical, and for several reasons more desirable, than through a canal with locks. I was further convinced that there would be no advantage to American commerce by this long and much more distant canal with locks, over the short sea-level cut proposed by De Lesseps at Panama. I saw also that *a very serious objection* to the Nicaragua canal existed in the fact that the harbor at Greytown, once possessing an entrance depth of about eighteen feet, had been obliterated by the sands of the sea and the local drainage of the tropical floods, in consequence of the almost total abandonment of that harbor by the San Juan river, which had been gradually directed into another channel, (the Rio Colorado,) which now conveys almost the whole flood waters of Lake Nicaragua through Costa Rica to the sea about twenty miles further east than Greytown. The restoration of this obliterated harbor on the sandy coast of Nicaragua is therefore a very different problem from that of the improvement of any existing harbor on the Atlantic seaboard. It is, in fact, the creation of a new harbor where none exists. Natural harbors on sandy sea coasts are always kept open by the flood discharges of rivers, or by the tidal discharges from estuaries, sounds, or other tidal basins. From New York to Mexico nearly all of our harbors are of this kind, and the almost fruitless attempts to improve them after years of study and the expenditure of many millions attest the uncertainty of such efforts. To undertake the creation of a harbor among sand banks where none exists, and where neither of the two natural forces are present to aid such effort, and to maintain the harbor intact afterwards, must necessarily be still more uncertain.

Seeing Gen'l Grant's name announced before his return, as the probable president of the Nicaragua canal company, I wrote to him soon after his arrival, and pointed out these objections to the proposed canal, and urged him to have nothing to do with it, assuring him that they would certainly prevent its construction during this century, and that I did not want to see him couple his name with what I felt sure would be a failure. In the letter I assured him that a ship railway would be made across Tehuantepec, and that for many reasons it would be preferable to a canal. Subsequently, in Mexico, in New Orleans, and in New York, during personal interviews in 1880 and 1881, I impressed upon him these views and my conviction that he would never live to see the building of the Nicaragua canal.

General Grant knew but little of the principles of mechanics, or of hydraulic engineering, and was not qualified by experience or education to judge of the practicability of a ship railway, nor of the engineering difficulties at Nicaragua. His son Jesse was educated as an engineer and quickly recognized not only the feasibility of the ship railway, but its advantages over the canal. He greatly regretted the use of his father's name in opposition to the ship railway, the success of which he thought certain. No doubt his arguments, coupled with the opinions I had expressed, induced his father to assure Hon A. G. Cochran, the counsel of the Ship Railway Company, about the 1st of January, 1882, that he would write to Senator Miller to take his name off the Nicaragua canal bill. Soon after this promise, the letter Ammen has published was received by me. I immediately sent, by Mr. Jesse R. Grant, the following reply:

WILLARD'S HOTEL,
WASHINGTON, D. C., *Jan.* 21, 1882.

GENERAL U. S. GRANT,
New York City:

DEAR GENERAL. I have the honor to acknowledge receipt of your letter of January 13th, in which you inform me that you feel it your duty to oppose the Ship Railway Bill. * * *

Appreciating the deep interest which you had always taken in the advance of American Commerce, and remembering your great anxiety, both in public and private life, to bring about a solution of the Isthmian problem, I felt very desirous that you should fully understand my project, what I proposed to do, and what aid from the Government I regarded as necessary. Hence it was that when I met you in Mexico, and afterwards on our journey home, I discussed the whole matter freely with you. I need hardly say that when I succeeded in removing your doubts as to the practicability of the work I was greatly gratified.

You point out in your letter certain objections to the bill recently introduced before Congress which, you say, have decided you to oppose its passage.

You will no doubt remember that when returning home on the steamer, I handed you a copy of the bill reported by the Interoceanic Committee to the last Congress. You read the bill and I had no reason to suppose that you failed to fully understand it. The Government guarantee therein provided for, was a three per centum semi-annual guarantee, not of interest upon bonds, but of stock dividends.

There were also provisions as to a canal, and payments for the same as in the case of the Railway. You remarked at the time that you did not think I would have much difficulty in passing the bill as it left no risk on the part of the Government in relation to the practicability of the railway. I now enclose you a copy of the bill I then showed you, and am satisfied that when you compare it with the bill more recently introduced, you will find that they substantially agree. If there be any difference I think that the latter bill is, in some respects, even more favorable to the Government.

As I understand it you have two serious objections to the bill, and they are as follows, viz:

1st, That the Company might never complete the work, and in this case, under its guarantee, the Government would be required to pay for an indefinite period.

2d, The liability of the Government might be made to attach to a large amount, for the construction of a canal merely, and without the practicability of a Ship Railway ever having been demonstrated.

I am unwilling to admit that the bill can be fairly made to bear this construction, but will not stop to argue the point, because I freely concede that the existence of the *slightest* doubt upon the subject renders a proper amendment imperative. I certainly never intended that any such construction should be placed upon the bill and shall see that the language is so changed as to make this construction impossible. I am willing that positive provisions shall be put into the bill to the effect that under no circumstances shall the Government pay upon its guarantee for a longer period than twenty years from and after the date of the testing of the first ten miles of railway and that no portion of the guarantee shall apply to any canal until the practicability of the project shall have been demonstrated by the successful transportation of a loaded vessel over ten miles of the railway.

I never contemplated the construction of a canal over any considerable distance of the route, and am very sure that under no circumstances will all portions of the canal, taken together, (if indeed any canal at all be constructed,) equal a distance of ten miles.

The bill certainly does not provide that the improvement of the river shall entitle the Company to the benefit of any part of the guarantee. I am satisfied that no such construction could be sustained for a moment, and yet I am entirely willing that a provision shall be incorporated into the bill concerning the matter in express language.

There are other minor matters mentioned in your letter, but as you have informed me verbally that you do not regard them as important, I will not weary you by referring to them.

Will you kindly advise me, by early mail, whether, if the bill be amended in accordance with the suggestions herein contained, you will not be willing to withdraw all opposition to it?

I feel satisfied that I shall build the Ship Railway, and I know that I can, and will, make it a complete success. Believe me, I would be unwilling to stake my reputation upon a doubtful experiment, or identify the closing years of my life with a failure. I am deeply anxious that when the Railway is in successful operation you shall be classed among its earliest and strongest friends.

Soliciting an early reply, I am, dear General,

Very sincerely yours,

(Signed) JAS. B. EADS.

Two days after the date of this letter I received the following:

NEW YORK, Jan. 23, 1882.

DEAR SIR: I showed your letter to father, and he expresses himself as satisfied with the letter, and I have just wired you to that effect. He has written to Miller explaining the error he made.

Very respectfully,

(Signed) J. R. GRANT.

To J. B. EADS, ESQ.

On the same day I received the following telegram:

"Letter received. Satisfactory. Sent copy to Miller. J. R. G."

Soon after this I received a brief letter from Gen. Grant (now mislaid) assuring me that he would not oppose our bill.

The letter of General Grant of Jan. 13, 1882, is a rehearsal of the misconstructions and misrepresentations published at the time by Ammen and Phelps regarding the ship railway bill then pending. As Ammen had a copy of his letter it is not to be supposed that he was ignorant of my reply, or of General Grant's admission that he was in error; and the fairness of Ammen's methods may be inferred from the fact that he has continued to use this letter to give color to his misrepresentations of the bill, after Grant had written to Senator Miller explaining the error he had made regarding it. J. R. Grant's letter proves that his father did this *immediately* after receiving my letter, which fact Ammen has carefully suppressed. He says in his present pamphlet he read the letter to Hon. A. H. Stephens, of Georgia, who said in reply:

> "Now I understand it all. Captain Eads would, under his bill, construct his ship railway without any cost, and indeed with a very considerable endowment, and then without ever attempting, or indeed intending to pass a ship from sea to sea, would have several lines of railway and harbors for small vessels, and a very profitable traffic in grain and other merchandise."

If Mr. Stephens ever said anything so unjust it simply proves that he never examined the bill and was grossly deceived by Ammen, for the bill was, soon after the date of Grant's letter, unanimously reported by the Senate committee on commerce to the Senate, with a strong report in its favor; and an equally favorable report was made by the House committee on Inter-oceanic Canals on this same bill which Ammen would lead the reader to believe was such a transparent fraud. These committee reports were made, too, in defiance of the utmost efforts of Ammen and his coadjutors to prevent them. The most that they did accomplish was to divide the majority who were in favor of some one or other isthmian transit for ships, and thus prevented action upon either bill during the 47th Congress.

Two or three weeks after this correspondence I wrote to Jesse R. Grant as follows:

"The sub-committee (five members of the committee of commerce of the Senate) have agreed to report unanimously in favor of the Ship Railway bill, and the full committee have authorized the printing of their report before final action is taken on it. * * * In the meantime, Ammen is doing all he can to defeat us. You will see by the enclosed slip, cut from the latest New Orleans newspaper, that U. S. Grant, Sr., and U. S. Grant, Jr., still constitute the Alpha and Omega of his forces, and are to share the honor of opposing the Ship Railway bill so long as he can keep them thus prominently before Congress and the country. Of course, I regret this for several reasons: 1st. Because I do not like to see the honored name of General Grant so prominently identified with a project which will inevitably prove a failure, even should Congress fail to pass my bill. 2d. Instead of occupying the impregnable position of a patriotic promoter of an isthmian highway for ships, whose great influence, official power, and high position were directed to the solution of the question, it places him in the attitude of a partisan, opposing a project for solving the problem which is supported by an overwhelming mass of expert testimony, and which avails of a location not only admitted by every one to be much superior to Nicaragua, but in a territory in which he has already important individual interests, whose inhabitants are his friends, and who are earnestly desiring to see the consummation of the enterprise which he seems to be opposing. 3d. I regret it because it gives color to the numberless misstatements that have been published throughout the country, to the effect that I had received a letter from General Grant upbraiding me with having deceived him as to the terms of my proposition, in consequence of which he had withdrawn from the directory of my company [in which he was never interested.] No less than three different articles to this effect were shown me yesterday, cut from recent newspapers. 4th. I regret it, because having assured me in his last letter that he would throw no obstacle in the way of my measure, this use of his name by Admiral Ammen keeps in its way the most serious obstacle which it has to encounter, and furnishes to Ammen the only possible means with which he can hope to defeat my bill. He totally disregards the advice of your father and is determined to use his name as long as he will permit it.

"As the Ship Railway becomes more and more popular, some of the blackmailers become more and more desperate and vicious. I send you a slip referring to the republication of a scandalous letter published two or three years ago; to-day the same paper republishes the libellous statement published by a New York paper against me about three years ago, and which it afterwards retracted."

The reader can judge of the spirit which prompts Admiral Ammen now, from the fact that he refers in his last pamphlet to this stale slander, long since refuted and retracted, and which, if true, could not possibly affect the merits of the canal or the ship railway.

Gen. Grant says in his letter of Jan. 13, 1882:

"I was somewhat surprised when I saw Senate bill No. 550, to incorporate the Maritime Canal Co. of Nicaragua. I supposed what I had said to

> Admiral Ammen and Capt. Phelps would probably prevent anything being done in the way of inaugurating that company until, as I suggested before in this letter, the other enterprises for interoceanic ship communication had proved a failure."

In bill No. 550, Gen. Grant's name was placed at the head of the list of incorporators, and the above extract proves that this use of it was made without his knowledge or consent by Ammen and Phelps, who were then interested with Menocal and other officers of the Government in the concession from Nicaragua.

The following additional extracts from the letter prove that he had no pecuniary interest with these parties at that time in their concession, if indeed he ever had:

> "I have felt it my duty to state these objections to you because you had reason to understand that while I might do nothing to favor your project (because I was not entirely satisfied with its feasibility) I would not antagonize or oppose it. * * * Assuring you that I have no pride in the establishing of any particular line or route for the transportation of vessels between the two oceans, but only to see the work done, and do not care by whom it is done provided it is under American auspices, and that I should wish your enterprise the same success that I would if my own name was connected with it, if inaugurated on terms that were not going to make the Government responsible for its failure.
>
> "I am very truly yours,
>
> "U. S. GRANT."

The following reply of Admiral Ammen to a Senator who wanted Gen'l Grant for the third term, gives the secret of this persistent use of his name by the holders of the Nicaragua concession. It will be found in the North Am. Review, Nov., 1885. I have italicised a portion of it:

> "Senator, There are a great many who would make good presidents, you among the number; I will be glad to vote for you if nominated, *but Gen'l Grant only in my belief can speedily bring about the construction of the Nicaragua Canal.*" * * *

The closing sentence of Gen'l Grant's letter expressed his true position on the Isthmian question. He had no pride in establishing any particular route between the two oceans, but only to see the work done; he cared not by whom, so it was inaugurated on terms that would not make the Government responsible for its failure. These are the utterances of a true patriot actuated by no pride of opinion or self-interest, but anxious that his country and the world should enjoy at the earliest moment the benefit of a ship transit somewhere across the Isthmus. While he was living, Admiral Ammen strove to place him in an entirely different position before the world. Now that he is dead, he makes an unwarrantable use of a private letter written four years ago under a total misapprehension of facts (which he promptly acknowledged) to make the public believe that he was opposing the Ship Railway bill in 1882, when in fact he had verbally assured Mr. Cochran that he would not oppose it; had written to me that he would place no obstacle in the way of its passage, and had given the same assurance to his son Jesse.

He would make the country believe, even now, that Gen'l Grant was, like himself, and his partners, Phelps, Menocal, Merry and other less prominent owners of the concession to Menocal, an interested advocate of a canal scheme, (of questionable feasibility and merit,) and the leading partner of a party of impractical government officers, said to be nine in number, (with other associates less creditable,) who had used their official influence to have their route surveyed and resurveyed at the public expense, without authority of Congress to increase, if possible, the cash value of their concessions from Nicaragua. Now that their project has totally failed, their concession having expired, the chagrined and embittered Admiral strives to defeat the Ship Railway bill by misrepresenting the true sentiments of the dead hero, and by the suppression of facts would now lower him to the same selfish and unenviable level with himself and his less prominent coadjutors. The final wrecking of their scheme in May, 1884, is thus related by one of them, Capt. Merry, of San Francisco, according to the Chronicle of that city:

> "A syndicate of New York and San Francisco capitalists had been formed to aid the construction of the canal under the Menocal concession, of which syndicate Gen'l Grant, Mr. Fish, the president of the bank, and others interested in that institution, were members. Admiral Ammen had taken up his pen to affix his signature to a construction contract, when a boy rushed in and announced the failure of the Marine Bank. Foreseeing the consequences of that failure, Admiral Ammen laid down his pen, and being unable to obtain the necessary financial aid our concession was allowed to expire."

"*Sic transit gloria mundi.*"

JAS. B. EADS.

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THE PANAMA CANAL.

The most interesting and vitally important question to the American people is the construction of the Isthmian Canal.

Every nation and the people of all countries are interested in this great work. There is a unanimity unequaled in history that it should be constructed, operated, and owned by the United States. But for all the purposes of commerce and of intercourse between the East and the West it will be an open sea, subject only to such restrictions as are admitted by all the world necessary for the protection of the waterway or for the protection or defense of the United States,

In the providence of the creation and decay of nations no state ever became independent so completely, so righteously or so timely as Panama. The hour struck for her when the world was watching the clock. No President ever did a more timely or patriotic act than did President Roosevelt in his recognition and defense of the Republic of Panama,

SPEECH

OF

HON. CHAUNCEY M. DEPEW,

OF NEW YORK,

IN THE

SENATE OF THE UNITED STATES,

THURSDAY, JANUARY 14, 1904.

◆

WASHINGTON.
1904.

SPEECH

OF

HON. CHAUNCEY M. DEPEW.

The Senate having under consideration Senate resolution No. 73, by Mr. GORMAN, calling upon the President for certain information touching former negotiations of the United States with the Government of New Granada, or Colombia, etc.—

Mr. DEPEW said:

Mr. PRESIDENT: The most interesting and vitally important question to the American people is the construction of the Isthmian Canal. There is absolute unanimity of opinion for the work to be begun, prosecuted and completed at the earliest possible moment. The opponents of the treaty are really aiding the enemies of the canal. If there ever has been a concert of action among any great railway corporations to defeat this most beneficent work of commerce and civilization, I am not aware of it; but if such a combination does exist, then its allies and its most efficient assistants are to be found among those who, under any device or excuse, are endeavoring to defeat the treaty with the Republic of Panama.

Piercing the Isthmus of Darien is no new idea. It has appealed to statesmen for hundreds of years, and now, four centuries after Columbus sailed along the coast of the Isthmus trying to find the opening which would let him into the Pacific, the completion of his dream is near at hand. Charles V was the ablest ruler of his century. The power of Spain under him and his successor included Cuba and Porto Rico, territories on the Gulf of Mexico and the Pacific Ocean, and the Isthmus of Darien and the Philippine Islands. His knowledge of geography was limited because of the meager discoveries of his period, but he did see that here was an opportunity for an eastern and western empire by connecting the two oceans, and set about energetically to accomplish the task.

Before his plans had matured he was succeeded by his son, that phenomenal bigot and tyrant, Philip II. He declared that it was sacrilege to undo what God had created, and therefore wicked to cut through the mountains for a canal. For three hundred years the wall of superstition built by this monarch prevented the union of the oceans. The initiative was with the United States, whose people are opposed to the opinions of King Philip, and believe the duty of man is to exploit, develop, utilize, and improve the waste places of the world, the air, the water and the earth. As early as the Administration of John Quincy Adams, our statesmen saw the necessity for this work. It was encouraged by almost every succeeding Administration. It originated the American idea of Henry Clay and has always been a bulwark of the Monroe doctrine.

In the past fifty years our Government has repeatedly asserted the necessity for the canal, and that it would look with extreme hostility upon its being built, or owned, or dominated by a foreign power. The discovery of gold in California and the rush of our people to the Pacific coast in 1849 opened the eyes of all Americans to the necessity of the United States controlling this highway between our eastern and western States. We made treaties with Great Britain to encourage private enterprise to do this work, and to prevent any European power from undertaking it. Our necessity was so great that we permitted without protest the French Canal Company of De Lesseps to proceed with their work. After the failure of that company and of private enterprises on the Nicaragua route, the duty of our Government became clear.

When we succeeded to the inheritance of Charles V, by the acquisition of Porto Rico, by the establishment of a friendly republic in Cuba and by the possession of California on our Pacific coast, of Hawaii midway and the Philippines at the gates of the Orient, the responsibility upon us to construct this canal was as much greater than it was upon that monarch as has been the growth of commerce and civilization from the fifteenth to the nineteenth century. For national defense, as well as national unity, there must be an unbroken line of coast from the northernmost limits of Maine to the northernmost limits of Alaska. For the employment of our capital and our labor in the ever-increasing surplus of our productions, we must reach, with the advantages which the canal would give us, the republics of South America and the countless millions in the old countries across the Pacific.

The Republic of Colombia recognizing this need sent here a diplomatic representative carrying a proposition. With scarcely any modification on our part this tentative agreement presented by Colombia was embodied in the Hay-Herran treaty. In that instrument was the most generous treatment of all interests to be acquired. We were to buy the plant and the properties of the French Company for $40,000,000. We were to give to Colombia $10,000,000 for a franchise which would be of incalculable benefit to that country. While we were permitted to exercise certain powers within a zone, six miles wide, for the protection of the canal, yet the sovereignty over that strip was recognized in every line of the treaty as remaining with Colombia. This concession was a weakness in the treaty for our interests.

The excuse for this concession was that our power was so great our interests could never be imperiled. There is no enlightened government in the world whose financial condition is not strong enough to construct through its territories a public improvement of such vast moment to its people, which would not grant freely the right to build to any company or government which would spend their millions to confer upon its citizens commerce, trade, industries, and development. This Colombian treaty, agreed to by the President, approved by the Secretary of State, and ratified by the Senate of the United States, was carried back to Bogota by the Colombian minister. Then began upon the stage of that capital a drama of unequaled interest, whether we look upon it as tragedy, comedy or opera bouffe. Marroquin, the Vice-President, had three years before, by a revolution, imprisoned the President, suspended the constitution, established martial law and begun ruling as dictator.

After many revolts against his authority, in a final revolution he defeated the liberals in a great battle, and they fled from the field, leaving upon it 7,000 of their dead. Marroquin was now absolute master of the constitution, the laws, the lives, and the property of the people of Colombia. He evidently proposed this treaty to secure $10,000,000 from the United States Government. He wanted money, and ten millions in gold, reckoned by the value of Colombian currency, would be about fifty millions in that Republic. But the speed and alacrity with which his offer was accepted opened his mind to visions of boundless wealth. He certainly developed, in his effort to compass these riches, Machiavellian statesmanship of a high order.

He declared the constitution operative, ordered an election and summoned a Congress. He had the army and absolute power; he controlled the machinery of elections, and brought to the capital his own representatives. He was in a position at any moment to again suspend the constitution, prorogue Congress or send them to jail. But he said, "This is my treaty, which I sent up to Washington when I was the government, which the United States has agreed to, and there must be some excuse which will appeal to the powers at Washington for more money. I must create an opposition to my Government." So he granted for the first time in three years a restricted liberty to the press, he liberated the editors and permitted the confiscated newspapers to resume. The "cue" given to them was to assail the treaty and the United States. This was to create the impression that there was a violent opposition, in a country where only five per cent of the people can read, against the Hay-Herran settlement. Next he created an opposition to the Government in Congress.

The orators to whom this rôle was assigned, with all the tropical luxuriance of Latin eloquence, denounced this infamous agreement, this frightful surrender of the rights and interests of Colombia. Marroquin, as Vice-President, presiding over the Senate, listened with pleasure to these fusilades upon his own statesmanship prearranged by himself. Every citizen of Colombia who had any intelligence, and every member of either House of that Congress knew that Marroquin had but to lift his finger and the vote for the treaty would be unanimous. This drama, accurately reported by our Minister Beaupre to the Secretary of State, closed with Vice-President Marroquin saying to us substantially: "You see the trouble I have in this uncontrollable opposition. Of course I want to carry out my treaty, but unless concessions are made, not to me, but to the pride and sentiments of my country, I am helpless. But if the United States will give $10,000,000 more, I think I can satisfy this opposition; at least I will risk my popularity, reputation and power in the effort."

The answer of the United States was an unmistakable and emphatic no. That answer has the unanimous approval of the public sentiment of our country. The Vice-President then said to the French company, "If you will pay that $10,000,000 extra out of your $40,000,000, we will ratify the treaty." The French company rejected the proposition. Then both the minister of Great Britain and the minister of Germany were approached to see whether a "dicker" could not be arranged and a sort of auction set up, with Great Britain, Germany and the United States as the bidders. The folly of this proposition was in its violation of the Monroe Doctrine by a Republic which had been many times its beneficiary, a Republic which now has quarrels upon its hands with Great Britain and

France because of outrages committed upon the citizens of those countries, which would lead to summary and drastic measures of reprisals except for the Monroe doctrine.

No better illustration of the understanding by the European governments of the sanctity of this article of American international law has been shown of late than this action of the representatives of these powers. No stronger proofs have been given of the interest of every great commercial nation in the construction of this canal in the interest of commmerce and civilization and its construction and control by the United States. These patriotic efforts of the Vice-President and dictator to secure more money by many methods of holdup were discouraging, but he did not despair. He had received an emphatic negative from the United States, had been refused by the French Panama Canal Company and turned down by Great Britain and Germany. But he had been trained in many revolutions where money had to be raised by other processes than the orderly ones of assessments and taxation upon all the people and properties of the country upon an equal basis. His resourceful genius was equal to the occasion.

He had called together his Congress, to carry out his programme of exploiting this asset of Colombia for many times more than the price at which he had agreed to sell it. Then occurred to him an idea of high finance which ought to make the most imaginative and audacious of our promoters blush at their incapacity. The Panama Canal Company had received from him while dictator upon the payment of a million dollars and 5,000,000 francs at par of stock of the new company, a concession which ran until 1910. The old concession expired in October, 1904, and for this the French company had paid Colombia 12,000,000 francs. With every concession, where vast amounts of money have been expended in good faith and large sums paid for the franchise, there are always equities to the defaulting party, but the new scheme dismissed the equities, the extension of the charter and the million dollars consideration paid, which had been spent.

The Congress, to the tearful regret and over the wishes of the dictator and vice-president, rejected the treaty by an almost unanimous vote and then adjourned. But Congressmen talk after adjournment. It is their habit in all countries, and the Senators and Representatives who participated in this picturesque drama of national aggrandizement said that the object of the adjournment was to wait until the old concession of the Panama Canal Company had expired, in October, then to recall Congress in extraordinary session in November, declare the concession canceled and sieze upon the property of the French Canal Company. Then, they said, we will offer to the United States the properties of the French Canal Company for the $40,000,000 which are to be paid that corporation and the ten million which are coming to us. "Of course," they argued, "the United States will be quite willing to enter upon an agreement of this kind, because the sum which they pay will be the same in amount as they have agreed upon under the terms of the Hay-Herran treaty and the contract with the French Canal Company."

There are two considerations in this choice bit of financiering which seemed never to have occurred to the statesman who guides the destinies of Colombia and the orators whom he placed in various rôles to play their instructed parts. The first was an utter indifference or ignorance of the fact that the United States had a national conscience. We are a commercial nation. Our people are trained to all the refinements of business obligations and all the reciprocal relations of contracts. Much as we want the canal, we never could have taken it by becoming a partner in this highway robbery of the property of the citizens of France. The Panama Canal scheme has been unpopular in France for many years, and French statesmen and politicians have been afraid to have any connections with it.

It is because of the millions of dollars lost by the French people in the investment and the scandals caused by the corrupt use, by the officers of the company, of much of the money subscribed. But here would be a case which no government could neglect. The French Canal Company, representing its several hundred thousands of French citizens, could say to the French Government, "Here are equities of great value, and here is a property for which we have paid our money that has been arbitrarily confiscated." Then we would have had upon our hands difficulties, compared with which the present ones are infinitesimal. We could not deny the justice of the demand of the French Government to land its army upon the Isthmus and enforce its claims. Here again the shrewd and able leader of Colombia—for he is both shrewd and able—counted first upon the cupidity of the United States to become a party to this robbery of the French, and then to the assertion of the Monroe doctrine to prevent France from demanding and maintaining the rights of her citizens.

Colombia, after failing to confiscate the French property in the canal, now appeals as a stockholder in the French Canal Company, to prohibit the transfer of the canal property to the United States without the consent of Colombia. France has recognized the Republic of Panama. In so doing she is committed to the transfer to the new sovereignty of all public property within its jurisdiction. The Colombian Government has no better claim to the Panama Canal, or jurisdiction over it, than Great Britain has over Bunker Hill. The same rule and construction will apply in case Colombia should, as has been suggested here, commence an action in New York against the Panama Railroad Company, a New York corporation, to compel a continuance of the subsidy of $250,000 a year to Colombia, instead of to Panama.

Up to this time, it will be said, no matter what was the conduct, no matter what the double dealing, no matter what the breaches of faith, no matter what the character of the hold up by the responsible Government of Colombia, that Government could act as it pleased upon granting rights, franchises, and properties within its own jurisdiction. This leads us at once to the new phase of the problem presented by the organization of the Republic of Panama. Panama was one of the first settlements made in the Western Hemisphere. After the city of Panama had been raided, robbed, and burned by Morgan and his pirates it was moved about seven miles, to the present site. It was the depot for hundreds of years for the commerce going between the Atlantic and Pacific oceans. The province was one of the last to throw off the yoke of Spain.

When General Bolivar succeeded in the revolution which he organized, he formed a loose-jointed republic out of the States of Colombia, Venezuela, Ecuador, and Panama There was little in common, territorially, commercially, or industrially between these States. After a few years Venezuela seceded and formed a separate government. Three years afterwards Ecuador did the same. Panama remained to all intents and purposes an independent Republic. In the new arrangement which was made Panama joined Colombia under a constitution which distinctly recognized the right of secession for any cause, and bound the several parts only to federal contributions according to their judgment. It was almost a counterpart of the Articles of Federation in our own country which were succeeded by the Federal Constitution. This relation continued practically from 1861 to 1886.

Then a dictator arose by the name of Nunez and got control of the army and navy and all the resources of the country. He suspended the constitution, the Congress, and the laws, and governed the country according to his own despotic will for a number of years. He subjugated the several States, overturned their sovereignty and forced them to become mere departments of the centralized power at Bogota. He adopted a system, under a so-called constitution, by which they were ruled as Spain governed Cuba—by governors, who were really captain-generals, with absolute power.

His enemies in the several States, and the patriots who resisted this suppression of liberty, were punished by imprisonment, exile or execution. From the time of this arbitrary destruction of the rights and liberties of the independent State of Panama that Republic has been in a continued condition of unrest and revolt. The duties collected at its ports of Panama and Colon were transmitted to Bogota. The taxes levied all went to Bogota. Of the subsidy of $250,000 a year paid by the Panama Railroad Company, $225,000 went to Bogota and $25,000 to the governor of Panama, appointed by the President of Colombia, to distribute in his judgment in the Department of Panama. Though Panama had only one-fifteenth of the population of the Republic, she contributed a large part of its revenues, but under this arbitrary constitution to which Panama never assented and never accepted, a constitution imposed by force and maintained by an army and an alien governor, she received during all these years practically no moneys for highways, for development, for education or for any of the needs of a live and growing State.

It is an interesting and picturesque view of the situation that the obligation of the United States to keep free transit across the Isthmus has worked both ways with Colombia. There have been many revolts in Panama in the effort on the part of tyranized, plundered and patriotic citizens to regain their liberties and rights. Every one of them has been sternly and ruthlessly suppressed by the central Government at Bogota. The success of the Bogotan Government was due in nearly every instance to the fact that the United States would not permit interruption of transit across the Isthmus. When the revolutionists would have seized the railroad which connected the oceans, the United States was the ally of the Bogotan Government to keep that open.

The result was that it was easy for the Government forces every time to put down a rebellion because the recruits of the State could not be gathered into a successful army. But lo! the working of this provision the other way. Citizens of Panama in November of this year, without a dissenting voice, reasserted the sovereignty of the State, which they had never surrendered, and proclaimed a Republic. The Colombian army joined the revolution. With the military forces of the Bogotan Government enlisting under the flag of the new Republic, the authority of Panama was complete throughout all its borders. When, therefore, some time after the Republic had been established and was in working order, and had at Panama its army, a Colombian army landed at Colon for the purpose of invasion and battle, the United States took toward it the same position that it had toward the revolutionists in the many efforts made by them for the freedom of Panama.

Our Government simply said to these soldiers, "You can not take possession of this railroad and interrupt traffic across the Isthmus. You can not engage in a battle or a series of battles which would stop communication for an indefinite period." At this point occurs an episode of which I find no parallel in ancient or modern history. The generals of the invading army said to the authorities of the new Republic, "We are here to suppress you, arrest you, carry you prisoners to Bogota and overthrow the Republic, but what will you give us to quit?" The sum of $8,000 was paid to the general, $5,000 for the officers and $3,000 for the men, and the invading army sailed away with the proud consciousness of having become the possessors of a part of the assets of the new Republic.

The story of the rule of Panama by these arbitrary satraps, sent down from Bogota, reads like the history of the rule of a Roman proconsul or the story of the methods of a Turkish governor. Arbitrary arrests and imprisonments without trial were common. Arbitrary assessments of shopkeepers and people of property were of everyday occurrence. These victims have been afraid heretofore to speak, but now the newspapers are filled with their stories. The price of life and liberty, after forcible seizure of person and property, was dependent upon the amount that the citizen disgorged. Under this tyrannical rule he was helpless before the courts or upon appeal to the central Government. Panama had as much right to revolt as did Greece from Turkey in the early part of the nineteenth century or Bulgaria in the latter part, and even more, for she had never consented to surrender her sovereignty to Colombia.

The people of Colombia outside of Panama number about 4,000,000, of which 2,000,000 are of Spanish descent and 2,000,000 a mixture of Caucasian, Indian and negro. There are few or no railroads or other highways in the country, there is no system of general education and dense ignorance prevails. A very small proportion of the people—a few thousand—are educated in the United States or in Europe, and form the governing class. Colombia is separated from Panama by hundreds of miles of mountains and impenetrable forests and swamps, inhabited by hostile Indians. Panama, on the other hand, has every facility, under good government, for a prosperous State. It is about as large as Maine. It has the same agricultural possibilities as the other Central American republics. It is rich in minerals and timber. Great cities, thriving populations and varied industries have always grown along the lines of commercial highways.

While the Panama Canal is being constructed and $150,000,000 spent within the Republic, there will be a wonderful industrial development. When the canal is opened and the commerce of the world is passing to and fro, the population of Panama will speedily rise above the million point. Merchandise of every kind for the supply of the ships sailing through it will bring capital and business talent to the cities on either side and through the interior. Sanitation, which has done so much for Cuba, will make the Isthmus as healthy as any part of the United States. With American ideas and American sovereignty over the large strip between the two seas, and American influence and example, schoolhouses will dot the land and the people become educated to an appreciation of their liberties and the proper exercise of them and of their marvelously favorable commercial, fiscal and industrial position.

But, it is said, the position of the United States in recognizing the Republic of Panama is a reversal of our national position on the subject of secession. I can not conceive of the argument by which comparison is made between the States of the American Commonwealth and Panama and Colombia. One hundred and seventeen years ago our forefathers saw that a nation could not be held together by such a rope of sand as the Articles of Federation. They met in convention, not under the rule of a dictator, not under the guidance of an autocrat, but as the accredited representatives of the people of the various States. When their labors were completed the country read, and the world was astonished by, the marvelous instrument which they had prepared.

The opening sentence of this great charter tells the story of the perpetuity of our national life: "We, the people of the United States, in order to form a more perfect union, establish justice, insure domestic tranquillity, provide for the common defense, promote the general welfare and secure the blessings of liberty to ourselves and our posterity, do ordain and establish this Constitution for the United States of America." For eighty years the national sovereignty was questioned only in debate. To preserve the institution of slavery, which was alien to our Declaration of Independence and a stain upon the spirit of our institutions, the civil war was inaugurated. To-day in every part of the country public sentiment is unanimous of its approval of the verdict which came from the arbitrament of arms. Our Union is sustained by a continued series of decisions of our highest court, by the judgment of our Presidents and Congresses and by the results of war, and, unimpaired by the passions of the conflict, will continue on forever. It is sacrilege to compare this majestic and impregnable fabric of government with the position of Panama in the Republic of Colombia.

In 1886 Mr. V. O. King, United States minister to Colombia, in a dispatch to Mr. Bayard, Secretary of State, tells precisely how the Colombian constitution was formed. He says:

> At the close of the late revolution President Nunez, whose term of office had then nearly expired and whose reelection was forbidden by the constitution then in force, issued a proclamation annulling that instrument and declaring an interregnum in the Government. He appointed provisional governors in all of the nine States, and directed them to nominate two delegates each, who, together, should constitute a national council to convene at the capital.

And this is the convention which is compared with that which formed our Constitution!

> On assembling in November, 1885, the first acts of this body were to ratify the conduct of Doctor Nunez and to confirm his appointments. It then elected him as chief magistrate of the nation for the term of six years, and proceeded to formulate a *projet* of fundamental principles for a new constitution to be submitted to the corporate vote of the municipal boards of aldermen throughout the country. Upon canvassing the returns the council—

This council of his own—

> declared a majority of such votes to be in favor of the new constitution, and thereupon proceeded to elaborate the instrument that is herewith submitted, which, from the number, fullness, and precision of the precepts enunciated, has left but little of the machinery to be devised by the executive or legislative power.

It will thus be seen that President Nunez, who was both a usurper and a dictator, arbitrarily annulled the constitution under which Panama consented to become a part of the Republic of Colombia, retaining, however, her entire sovereignty and right of secession. The tremendous difference between the formation of our Constitution and that of Colombia in 1886 is in the fact that this so-called convention, which framed the constitution destructive of the State, was composed of the instruments of the dictator, appointed by himself, and that neither in the election of delegates to the convention nor the ratifying of the treaty did the people of Panama or their representatives have any voice whatever?

Panama, an independent State, robbed by armies of her liberties, tyrannically and arbitrarily governed without her consent, suffering under intolerable tyranny and threatened with the confiscation of a public improvement upon which depended her existence, simply retakes, and demonstrates her ability to hold, the sovereignty of which she had been despoiled. But, say the critics of the President, the officers of the United States inaugurated this rebellion and ships were dispatched to aid the revolt before it was ever intended. No one doubts that it was the duty of the President to keep the highway open across the Isthmus. No one doubts that if the rights of American citizens were in peril because of revolution or anarchy the United States must have a force on the spot sufficient for their protection. The dispatches of Minister Beaupré are illuminating on this subject.

The forces of the United States arrived at the Isthmus on November 3. The revolution broke out on November 4. The building of the canal was vital to Panama. Except for the money to be distributed at Bogota for the concession, its construction was of little account to the Republic over the mountains. The delegates from Panama to the Congress were apparently the only independent members of that body. When they arrived on July 5 they immediately notified Vice-President Marroquin that if the treaty was rejected Panama would revolt. This notification was so public that the minister of the United States was enabled to write it to our Government.

On August 17 the treaty was rejected and the representatives from Panama expressed their purpose so emphatically that our minister was able to inform the Secretary of State that they had determined to break loose from the Bogota Government and form an independent republic. Two things are evident: One, Marroquin believed his forces upon the Isthmus were sufficient to prevent the revolt from succeeding. He evidently thought it would be the old process by which the patriots would organize at different places and could not come together without having a conflict along the line of the railroad with the forces of the central Government, that such a conflict would interrupt travel and communication and that the United States would, as before, prevent the revolutionary army from concentrating or making any headway. It never occurred to him that his own army would go over to the revolutionists, and then he would be outside the breastworks.

It is perfectly plain that these delegates, on returning in August to Panama, were joined by all the leading citizens, and that they had plenty of time between the middle of August and November 4 to perfect their plans for a successful revolution. So the President knew perfectly well by advice from our minister at Bogota, from our naval officers at Panama and Colon and from newspaper reports which were the common property of everyone, that such an uprising would occur as to require of the United States the presence of a force sufficient to protect our citizens and to carry out our treaty obligations.

The farcical character of the action of the Colombian Congress and its complete control by Marroquin, together with the fact that Colombia could not subdue the revolution in Panama without the aid of the United States, are demonstrated by the following dispatch, sent November 6, two days after the revolution in Panama, by our Minister Beaupré:

> Knowing that the revolution has already commenced in Panama, ——— ——— says that if the Government of the United States will land troops to preserve Colombian sovereignty and the transit, if requested by the Colombian chargé d'affaires, this Government will declare martial law, and by virtue of vested constitutional authority, when public order is disturbed, will approve by decree the ratification of the canal treaty as signed; or, if the Government of the United States prefers, will call extra session of Congress and new and friendly members next May to approve the treaty.

Because it was a telegram the name was indicated by a blank. The blank undoubtedly meant Marroquin, for no one else could have made such pledges.

Mr. President, that is an exhibition of arbitrary power. of the confidence of the dictator of his ability to do whatever he pleases, of which I think there is no parallel anywhere. He says, in effect, to the United States: "A revolution has broken out in Panama, my army has gone over to the Republic and I am helpless. Now, if you will put down that revolution at my request I will abandon the claim of $10,000,000 more than agreed to which our Congress made. I will dismiss all pretense that this Congress had any power or was other than myself. I will do everything you want. I will suspend the constitution. Then I can do anything and will ratify this treaty—the Hay-Herran treaty—or do any other old thing you may desire; or, if you have constitutional lawyers in the Senate who doubt my ability or power to act under a suspension of the constitution, I will put the constitution again in force and summon the members of Congress here. Each one of them will do what I tell him, and Congress will ratify the treaty in any form that you suggest."

Yet our friend the Senator from Nevada [Mr. NEWLANDS] has just eloquently and at great length proved—to his own satisfaction—that war exists between the United States and Colombia; that war exists by the act of the United States landing 42 marines on the Isthmus, when Marroquin had 1,500 soldiers who deserted his standard and 400 others who left for home when their general got $8,000; that war exists between the United States and Colombia when, during all the time from the first telegram of President Roosevelt until now, the Colombian minister has been here, having daily communication with the Secretary of State. When every diplomatic condition which means peace, and continuing peace, exists between the United States and Colombia, the Senator from Nevada says we have war. There must be lurid imaginings among Senators who, instead of living within the limits of the city, where they are in contact with hard facts, reside and muse in the rural outskirts of the capital. [Laughter.]

Our diplomatic history bristles with recognitions of de facto governments formed by revolutions. Where the sympathies of our people were with the revolt, Presidents have paid little attention to the possibilities of success or the offensive or defensive means of the revolting provinces or states. The principle of international law that recognition is wholly in the discretion of the power which makes it and is not a cause for war is too elementary to discuss. Our position with Cuba went far beyond this. We warned the Spanish Government to get out of Cuba when there was no war between us simply because of intolerable internal conditions on that island. We finally drove the Spanish army out of Cuba and then governed it for two years. We refused to let Cuba recognize the Cuban debt, the bonds of which had been sold in Europe based for security upon Cuban revenues.

Our obligation for forty-eight years to Colombia, to Panama, to our citizens and the world has been to keep communication and transit open and unmolested between the oceans. It is a territorial burden and runs with the land. It binds the United States to keep off the premises all hostile trespassers, whether they are the armies of the great powers of Europe, of Colombia or of the contiguous people of Panama.

Marroquin, amidst the ruins of his scheme by the successful revolt of Panama, is not discouraged. He rises gaily and hopefully to new efforts. He proposes, notwithstanding his machine Congress has adjourned, to give us now the canal on our own terms if we will suppress the Panama Republic. When that is rejected, he has another resource. It appears in a dispatch in the Washington Post of January 10, dated January 8, from Bogota, from Clifford Smythe, former consul at Cartagena, Colombia. Mr. Smythe says he is authorized by President Marroquin to quote him as follows:

> The people of Colombia—

That is delightful from Marroquin—"the people of Colombia"—

> still hope that actual conflict may be averted through Democratic intervention in the Senate. Personally, I count on the assistance of the Democratic party and the great American people to save the sacred rights of Colombia, which have been so scandalously wounded.

The trouble with President Marroquin is, in the first place, he does not understand that the Democratic party is not in a majority in the two Houses of Congress and that it has not the Presidency; he does not understand that it is not likely in the near future to have either; he does not understand that the relations between the Democratic party and the people are such that if he did understand he would not couple them in the way he has in this authorized dispatch.

Then he does not understand another thing, Mr. President—I say this not to do injustice to the Democratic party—that the Democratic State of Louisiana has unanimously, by its legislature, directed its Senators to vote in favor of the ratification of this treaty; that the Democratic State of Mississippi has, through its legislature, directed its Senators to vote to ratify this treaty; and that in all probability if the other Southern States, who will be more benefited a hundred times over than all the rest of the United States by the construction of this canal, should meet in their legislatures, they would not stand in the position of saying, "We keep the goods while we denounce the method by which they were secured."

The Republic of Panama had absolute authority over its territory without any pretense of opposition from outside or inside of the Republic at the time of its recognition by our President, and has still. Our Government recognized the Republic of Panama on November 13. Certainly there had been no change in the conditions there when three days afterwards France did the same, nor when eleven days afterwards Austria-Hungary also extended its recognition; nor, still more significant, when, fourteen days afterwards, Germany—most particular and scrupulous about anything occurring on this hemisphere—extended her diplomatic recognition. In less than fifty days sixteen of the powers of the world had established relations with the young Republic. If these old countries—Great Britain, Germany, France, Russia. China, Japan. Sweden and Norway, Belgium, Switzerland, Italy and Denmark—find the conditions such upon the Isthmus that they can take a step which in the chancelleries of the Old World means so much, surely our younger and more progressive diplomacy has ample excuse for preceding them by a few days.

Now, sir, we had no other hand nor part in this revolution than the example of the American colonies and the successful application of the principles of liberty in the United States, which have created republics and undermined thrones all over the world. The advantages of the treaty with Panama over that with Colombia to the United States are incalculable. Instead of six miles for the canal zone, there are ten on each side of the waterway. Instead of a limited sovereignty, which would necessarily lead to endless complications. this territory is ceded outright and in perpetuity to the United States. At the termini of the canal it is vital that there should be unquestioned jurisdiction of the United States. In this territory the Government has complete authority for three marine leagues from Panama into the Pacific Ocean and three leagues from Colon into the Caribbean Sea. The Republic of Panama surrenders the right to impose port dues or duties of any kind upon ships and goods in transit across the Isthmus. The sole power to impose tolls and collect them rests with the United States.

Every nation and the people of all countries are interested in this great work. There is a unanimity unequaled in history that it should be constructed, operated and owned by the United States. We are distant by 3,000 miles of ocean from Europe. We are not in conflict and can not be embroiled in the jealousies or conflicts of the great powers. They trust our honor to keep this waterway inviolate as the highway of the nations. They see that the problem which Columbus sought to solve will so find its solution under the auspices of the United States and it will not be, as it would under the auspices of Charles V, a Spanish canal, nor will it be, as under De Lesseps, a French canal, but for all the purposes of commerce and of intercourse between the East and the West it will be an open sea, subject only to such restrictions as are admitted by all the world necessary for the protection of the waterway or for the protection or defense of the United States.

In the providence of the creation and decay of nations no state ever became independent so completely, so righteously or so timely as Panama. The hour struck for her when the world was watching the clock. No President ever did a more timely or patriotic act than did President Roosevelt in his recognition and defense of the Republic of Panama.

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The Isthmian Canal

By

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Chairman and Chief Engineer, Isthmian
Canal Commission

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THE ISTHMIAN CANAL.

By Lieut. Col. Geo. W. Goethals, U. S. Army,
Chairman and Chief Engineer, Isthmian Canal Commission.

A canal connecting the Atlantic and Pacific oceans has occupied public attention for upward of four centuries, during which period various routes have been proposed, each having certain special or peculiar advantages. It was not until the nineteenth century, however, that any definite action was taken looking toward its accomplishment.

In 1876 an organization was perfected in France for making surveys and collecting data on which to base the construction of a canal across the Isthmus of Panama, and in 1878 a concession for prosecuting the work was secured from the Colombian Government.

In May, 1879, an international congress was convened under the auspices of Ferdinand de Lesseps, to consider the question of the best location and plan of the canal. This congress, after a two weeks' session, decided in favor of the Panama route and of a sea-level canal without locks. De Lesseps's success with the Suez Canal made him a strong advocate of the sea-level type, and his opinion had considerable influence in the final decision.

Immediately following this action the Panama Canal Company was organized under the general laws of France, with Ferdinand de Lesseps as its president. The concession granted in 1878 by Colombia was purchased by the company, and the stock was successfully floated in December, 1880. The two years following were devoted largely to surveys, examinations, and preliminary work. In the first plan adopted the canal was to be 29.5 feet deep, with a ruling bottom width of 72 feet. Leaving Colon, the canal passed through low ground to the valley of the Chagres River at Gatun, a distance of about 6 miles; thence through this valley, for 21 miles, to Obispo, where, leaving the river, it crossed the continental divide at Culebra by means of a tunnel, and reached the Pacific through the valley of the Rio Grande. The difference in the tides of the two oceans, 9 inches in either direction from the mean in the Atlantic and from 9 to 11 feet from the same datum in the Pacific, was to be overcome and the final currents reduced by a proper sloping of the bottom of the Pacific portion of the canal. No provisions were made for the control of the Chagres River.

In the early eighties after a study of the flow due to the tidal differences a tidal lock near the Pacific was provided. Various schemes were also proposed for the control of the Chagres, the most prominent being the construction of a dam at Gamboa. The dam as proposed afterwards proved to be impracticable, and this problem remained, for the time being, unsolved. The tunnel through the divide was also abandoned in favor of an open cut.

Work was prosecuted on the sea-level canal until 1887, when a change to the lock type was made, in order to secure the use of the canal for navigation as soon as possible. It was agreed at that time that the change in plan did not contemplate abandonment of the sea-level canal, which was ultimately to be secured, but merely its postponement for the time being. In this new plan the summit level was placed above the flood line of the Chagres River, to be supplied with water from that stream by pumps. Work was pushed forward until 1889, when the company went into bankruptcy; and on February 4 of that year a liquidator was appointed to take charge of its affairs. Work was suspended on May 15, 1889. The New Panama Canal Company was organized in October, 1894, when work was again resumed, on the plan recommended by a commission of engineers.

This plan contemplated a sea-level canal from Limon Bay to Bohio, where a dam across the valley created a lake extending to Bas Obispo, the difference in level being overcome by two locks; the summit level extended from Bas Obispo to Paraiso, reached by two more locks, and was supplied with water by a feeder from an artificial reservoir created by a dam at Alhajuela, in the upper Chagres Valley. Four locks were located on the Pacific side, the two middle ones at Pedro Miguel combined in a flight.

A second or alternative plan was proposed at the same time, by which the summit level was to be a lake formed by the Bohio dam, fed directly by the Chagres. Work was continued on this plan until the rights and property of the new company were purchased by the United States.

The United States, not unmindful of the advantages of an isthmian canal, had from time to time made investigations and surveys of the various routes. With a view to government ownership and control Congress directed an investigation of the Nicaraguan Canal for which a concession had been granted to a private company. The resulting report brought about such a discussion of the advantages of the Panama route to the Nicaraguan route, that by an act of Congress, approved March 3, 1889, a commission was appointed to—

> make full and complete investigation of the Isthmus of Panama, with a view to the construction of a canal * * * to connect the Atlantic and Pacific oceans * * * and particularly to investigate the two routes known respectively as the Nicaragua route and the Panama route, with a view to determining the most practicable and feasible route for such canal, together with the approximate and probable cost of constructing a canal at each of the two or more of said routes.

The commission reported on November 16, 1901, in favor of Panama, and recommended the lock type of canal. The plan consisted of a sea-level section from Colon to Bohio, where a dam across the Chagres Valley created a summit level 82 to 90 feet above the sea, reached by two locks. The lake or summit level extended from Bohio to Pedro Miguel, where two locks connected it with a pool 28 feet above mean tide, extending to Miraflores, the location of the final lock. The ruling bottom width of the canal prism was fixed at 150 feet, increased at the curves and in the submerged channels. In Panama Bay the width was fixed at 200 feet, and in the artificial channel in Limon Bay 500 feet was adopted, with turning places 800 feet wide. The minimum depth was 35 feet, and the locks were to have usable lengths of 740 feet and widths of 84 feet. The commission assessed the value of the rights, franchises, concessions, lands, unfinished work, plans, and other property, including the railroad of the New Panama Canal Company, at $40,000,000.

By act of Congress, approved June 28, 1902, the President of the United States was authorized to acquire, at a cost not exceeding $40,000,000, the property rights of the New Panama Canal Company on the Isthmus of Panama, and also to secure from the Republic of Colombia perpetual control of a strip of land not less than 6 miles wide, extending from the Caribbean Sea to the Pacific Ocean, and—

> the right * * * to excavate, construct, and to perpetually maintain, operate, and protect thereon a canal of such depth and capacity as will afford convenient passage of ships of the greatest tonnage and draft now in use.

In event the provisions for the purchase, and for securing the necessary concession from Colombia could not be carried out, the President was authorized to secure the rights necessary for the construction of the Nicaraguan Canal.

The law also provided, after the foregoing arrangements had been perfected, that—

> the President shall then, through the Isthmian Canal Commission * * * cause to be excavated, constructed, and completed a canal from the Caribbean Sea to the Pacific Ocean. Such canal shall be of sufficient capacity and depth as shall afford convenient passage for vessels of the largest tonnage and greatest draft now in use, and such as may be reasonably anticipated.

To enable the President to carry out these provisions certain sums were appropriated and a bond issue, not to exceed one hundred and thirty millions of dollars, was authorized. By this act Congress, in accepting the estimates accompanying the report of the commission of 1901, adopted the type proposed by the board, or a lock canal.

Pursuant to the legislation, negotiations were entered into with Colombia and with the New Panama Canal Company, with the end that a treaty was made with the Republic of Panama granting to the United States control of a 10-mile strip, constituting the Canal Zone, with the right to construct, maintain, and operate a canal. This treaty was ratified by the Republic of Panama on December 2, 1903, and by the United States on February 23, 1904.

The formal transfer of the property of the New Panama Canal Company on the Isthmus was made on May 4, 1904, after which the United States began the organization of a force for the construction of the lock type of canal, in the meantime continuing the excavation by utilizing the French material and equipment and such labor as was procurable on the Isthmus.

The question of a sea-level canal was again agitated, and secured such recognition that the President convened an international board of engineers, consisting of 13 members, to assemble at Washington on the 1st day of September, 1905, for the purpose of considering the various plans for the construction of the canal that would be submitted to it.

The plans submitted may be briefly summarized as—

(1) That of the commission of 1901, which has already been explained.

(2) A lock canal with terminal lakes proposed by Mr. Lindon W. Bates, and for which three projects were proposed. The one which he appeared to favor contemplated a summit level of 62 feet above the sea, created by a dam at Bohio, and an intermediate level of 33½ feet above mean tide, effected by a dam at Mindi. This plan provided four locks—at Mindi, Bohio, Pedro Miguel, and Sosa. A variant of the plan contemplated a dam at Gatun instead of at Bohio, showing that, at least for a 30-foot head, the Gatun location was not considered by him as unfavorable or offering any difficulties respecting the foundations. His other plans were modifications of this, the summit levels being 27 or 62 feet, but in each instance the lock type was advocated.

(3) The plan proposed by Mr. Bunau-Varilla, carried out the ideas of the first French company, namely, the construction of a lock canal with a summit level 130 feet above mean tide, to be ultimately converted into a sea-level canal, or what he calls the Straits of Panama. The locks were to be constructed so that as the levels were deepened by dredging they could be eliminated, navigation continuing during the enlargement and transformation. The material removed by the dredges was to be deposited in the lake formed of the upper Chagres River by a dam at Gamboa, and any suitable locations in the various pools between the locks. In commenting on this plan the Board of Consulting Engineers concluded that—

> After a full and careful consideration of all the features of Mr. Bunau-Varilla's plan, the board is of the opinion that it should not be adopted for the Panama Canal for the following reasons:
>
> 1. The construction of the large locks required under the present law and necessary for the accommodation of the traffic seeking the canal after its completion makes it quite impossible to complete the preliminary lock canal even nearly within the period stated.
>
> 2. The excessive cost of transformation added to the loss of costly locks and other appurtenant structures required by the preliminary lock canal.
>
> 3. If the lock canal is likely to be retained for many years, it should be made for the most efficient service, and not be encumbered with modifications in lock construction which would prove inconvenient in use.

(4) A plan proposed by Maj. Cassius E. Gillette, a lock canal with a summit level 100 feet above mean tide by the construction of a dam across the Chagres Valley at Gatun.

No sea-level plan was submitted for consideration, so that the board outlined a general plan of its own, and for purposes of comparison adopted as the lock type a 60-foot summit level canal. Two levels were used, the summit level was carried by an earth dam at Bohio, and the intermediate level by an earth dam at Gatun, each dam sustaining a head of 30 feet. It is to be noted that no difficulties were anticipated in the construction of these dams, and there was no dread or fear of the foundations.

As the result of its deliberations, the board submitted a majority report and a minority report signed by five of its members, the former advocating a sea-level canal and the latter a lock canal, with the summit level 85 feet above mean tide.

The Isthmian Canal Commission, with one dissenting voice, recommended to the President the adoption of the lock type recommended by the minority, which was also strongly advocated by the then chief engineer, Mr. John F. Stevens. The President, in the message to Congress, dated February 19, 1906, stated:

> The law now on our statute books seems to contemplate a lock canal. In my judgment a lock canal, as herein recommended, is advisable. If the Congress directs that a sea-level canal be constructed its direction will, of course, be carried out; otherwise the canal will be built on substantially the plan for a lock canal outlined in the accompanying papers, such changes being made, of course, as may be found actually necessary, including possibly the change recommended by the Secretary of War as to the site of the dam on the Pacific side.

On June 29, 1906, Congress provided that a lock type of canal be constructed across the Isthmus of Panama, of the general type proposed by the minority of the Board of Consulting Engineers, and work has continued along these lines. As originally proposed, the plan consisted of a practically straight channel 500 feet wide, 41 feet deep from deep water in the Caribbean to Gatun, where an ascent to the 85-foot level was made by three locks in flight. The level is maintained by a dam approximately 7,700 feet long, one-half mile wide at the base, 100 feet wide at the top, constructed to 135 feet above mean tide. The lake formed by this dam, 171 square miles in extent, carried navigation to Pedro Miguel, where a lock of 30 feet lift carried the vessel down to a lake 55 feet above mean tide, extending to Sosa Hill, where two locks overcame the difference of level between the lake surface and the Pacific. Nineteen and eight-hundredths miles of the distance from Gatun to Sosa Hill had a channel 1,000 feet at the bottom, a minimum channel for 4½ miles through Culebra of 200 feet at the bottom. The balance of the distance varied in width to 800 feet, the larger portion of the entire canal being not less than 500 feet. The depth of water was fixed at 45 feet. The lake assured a perfect control of the Chagres River.

Certain changes have been made in the original project, the most important being the withdrawal of the locks from Sosa to Miraflores, which was recommended and adopted in December, 1907. This resulted in a change in the direction of the channel in Panama Bay. A breakwater is being constructed from Sosa to Naos Island which, by cutting off the silt-bearing cross current, which has always been troublesome, protects the channel against silting.

A second change is the widening of the 4½ miles of Culebra cut to a width of 300 feet at the bottom. This was done by executive order and was not made on the recommendation of the commission.

A third change is the location of the breakwaters in Colon Harbor. The necessity for these breakwaters was made apparent in the latter part of January, when a storm of some magnitude seriously interfered with shipping. As originally proposed for both the sea level and lock types, the breakwaters were parallel to the axis of the channel excavated in Limon Bay. If so constructed, sufficient area would not be given to dissipate the waves entering head on into the channel, and they would not afford much, if any, protection to shipping. These breakwaters are to be built out from Manzanillo Island and Toro Point, so as to give a sheltered anchorage, and also an opportunity for such expansion to the waves as to break them up.

A fourth change is in the dimensions of the locks. As proposed by the minority they were 900 feet by 95 feet, usable lengths and widths. These dimensions were subsequently changed by the commission at the instigation of the President to dimensions 100 feet wide and 1,000 feet long. The width was again increased to 110 feet on the recommendation of the General Board of the Navy, so as to accommodate any possible increase in beam of future battleships.

The Gatun dam is to consist of two piles of rock 1,200 feet apart and carried up to 60 feet above mean tide. The space between them and up to the required height is to be filled by selected material deposited in place by the hydraulic process. During the construction of the north side of the south rock pile a slip occurred in November last at the crossing of the French Canal. This was the fifth slip that occurred at this point, the rock settling to some extent, but generally slipping sidewise until the angle of repose was reached. In this connection it is to be noted that the silt deposits in the channel had not been removed. This slip would probably have passed unnoticed, as did the former ones, but for the fact that at the time a flood in the Chagres River had attained such proportions as to cover a portion of the Panama Railroad tracks just south of Gatun. A newspaper correspondent, going from Colon to Panama, saw his opportunity for a sensational story, and attributed the flood to the dropping of the Gatun dam into the subterranean lake under the dam and locks, which another faker had previously discovered, and the news of the destruction of the Gatun dam was cabled to the States.

The slip did not affect the south slope or side of the rock pile. It was entirely local and did not in any way interfere with the work. It would not have occurred had steps been taken during construction to give the proper slope to the rock pile, but economy of time and money did not warrant such precaution. As stated by one of the engineering publications, "We can state from actual personal examination that this incident has absolutely no engineering significance."

As a result, however, the public is told that dire disaster will follow the undertaking unless the present plans are abandoned and the Straits of Panama constructed, that is a sea-level canal across the Isthmus 500 to 600 feet wide. To accomplish this, however, a lock canal must be built first, and subsequently widened and deepened until the ideal is reached. There is no data available for such a canal. With mountains instead of hills to be removed estimates are, of course, impossible; so the most optimistic figures, suitable alone to the ideal, are offered as a bait. In any event it is also claimed that Bohio should have been selected for the site of the dam in lieu of Gatun.

As between Gatun and Bohio, at both places the distance from the natural surface to the rock is so great that any attempt to found the dam on the last-named material will be attended by enormous expense. At Bohio the gorge in its lower strata is filled with water-bearing gravel and to make the dam safe the underflow through these strata would have to be cut off by some means extending down 165 feet. No such strata exist at Gatun, so, for this reason alone, leaving out of consideration the advantages in the control of the

Chagres River and to navigation by reason of the greater extent of lake, Gatun offers the better site.

Both the majority and minority of the Board of Consulting Engineers considered Gatun a suitable location for a dam; the former adopted it for the typical lock canal used for comparison with the sea-level canal, the latter for the 85-foot summit-level canal. The majority, however, feared the existence of an underground flow in case of the higher dam, but investigations have failed to disclose any. The great mass of underlying material is not sandy and gravelly deposits as was supposed, but a mixture of these materials so firmly cemented together with clay as to make the strata in which they occur impervious to water.

I venture the statement, without fear of contradiction, that the site of no public or private work of any kind has received such a thorough and exhaustive examination and investigation as the foundation of the dam and locks at Gatun. There is no longer a doubt concerning any of the underlying strata; neither the impermeability, nor the ability of the foundations to bear the loads that will be brought upon them, can be questioned if the data be carefully and impartially examined. The investigations fail to disclose any water-bearing strata or the existence of that underground stream with a discharge equal to the Chagres River itself, which was recently asserted as a fact on the floor of the Senate.

In this connection the statement is also made that the change in the location of the locks at the Pacific end was due to our demonstrated inability to construct the dams, and that as the foundation at Gatun is of the same material, it necessarily followed that the Gatun dam is also impossible of accomplishment.

The majority of the Board of Consulting Engineers in its report states that—

> The dam at La Boca, between San Juan Point and the Sosa Hill, unless carried down to bed rock at that location, would be placed upon a far worse foundation than that proposed at Gatun or Mindi. The La Boca site is one covered by an ooze of mud or silt, with some sandy material overlying the rock. * * * Unless some feature equivalent to that of a heavy masonry core characterized the design of the dam at this point, or unless a resort be made to dredging down to bed rock or near to it, and refilling with suitable material, or an earth dam at this location be made very massive, it would be in grave danger of being pushed bodily out of place by the pressure due to the head of water in the reservoir.

We found the material in the foundations of these dams not only worse than at Gatun, but in nowise comparable. In the former a covering of ooze and silt, in the latter firm ground with a few soft or marshy spots.

I know that the La Boca dams could be built to safely withstand the heads of water in the resulting lake by adopting either the method of dredging out the ooze or by giving massive dimensions to the superimposed structure. The engineering committee and the majority of the commission preferred the former method. In either case the cost would exceed the original estimates, and in addition it is a military blunder to push the locks to and beyond the proper line of defense, especially when the canal is a military necessity to this country. That the dams could be built is evidenced by the fact that the west toe of the Sosa-Corozal dam was carried across the valley on the ooze as an embankment for a railroad to be utilized in transporting stone for the Pacific locks. The charge, therefore, that the dams could not be constructed is not true, and the analogy at Gatun does not follow. Nor is there any truth in the statement that the military necessity was an afterthought as has been insinuated.

I visited the Isthmus in 1905 with a committee of the Board of National Coast Defenses, with which I was associated at that time, for a study of the defenses of the canal. When the location of the locks at the Pacific end was fixed, I was directed to call the Secretary of War's attention to the military necessity of withdrawing the locks to the interior. This I did, with the result that in forwarding the report of the Board of Consulting Engineers to the President he calls attention to the fact as follows:

> The great objection to the locks at Sosa Hill is the possibility of their destruction by the fire from an enemy's ship. If, as has been suggested to me by officers of this department entitled to speak with authority on military subjects, these locks may be located against and behind Sosa Hill in such a way as to use the hill as a protection against such fire, then economy would lead to the retention of this lake. * * * If, however, Sosa Hill will not afford a site with such protection, then it seems to me wiser to place the locks at Miraflores.

In forwarding the report to Congress, the President calls attention to the change recommended by the Secretary of War in the location of the locks on the Pacific side. The so-called afterthought appears, therefore, as a conclusion reached long before I had any connection with the work.

Discredit is also thrown on the Gatum dam because there has been a desire to reduce the height from 135 to 105 feet. The original height was arbitrarily fixed to secure an excess of weight, so as to fully compress the underlying material supposed to be largely silt deposited by the river. Subsequent investigations show that the supposed compressibility does not exist; that a marine, not a river deposit is encountered. The greater the height of the dam the greater the difficulty of constructing the upper portion, and the greater the cost, both in time and money. From present available data, if the lake should take the total discharge of the Chagres River, the water surface would not exceed 90 feet; the top of the locks, 92 feet above sea level, would permit escape of the water long before it could reach the crest of the dam. Why then go to the expense of the extra height of the dam, and what is to be gained thereby? Assuming the crest of the dam as 100 feet wide, uniform slopes from the rock piles would give a height of 105 feet, and this height was suggested. Because as an additional reason it was mentioned that the pressure over the base would be more uniformly distributed by a dam with the cross section proposed, the opponents of the present project, without ascertaining the facts, point to the change as a desire to secure a uniform base pressure, and use it as an argument against the stability of the foundation.

Much also has been made of the fact that in the testimony before one of the congressional committees mention was made of securing the stability of the superstructure by balancing the dam on the underlying material. Naturally the testimony is read and discussed in such a way as to leave the impression that the entire dam is to be so constructed. The ground to be covered by the dam is crossed by three water courses, the Chagres River, the French Canal, and the West Diversion, and between these streams the ground is undulating, Spillway Hill reaching a height of 110 feet above sea level. It is not remarkable or unprecedented that there should be depressions which undrained become soft with the excessive rainfall. Except for these the ground is firm. It is in the crossing of these soft spots that slips have occurred and are liable to occur, and to which the balancing method referred. They are relatively small in extent and when drained or filled cause no trouble, as experience at the La Boca embankment clearly proves.

As previously stated, the Gatun dam satisfactorily solves the problem of the control of the Chagres, and there should be no doubt in the mind of anyone who impartially examines the data that the solution is not only feasible, but absolutely safe. As there has never been any question raised as to the safety and stability of the dams at Pedro Miguel and Miraflores, with the Gatun dam accepted, other things being equal, the relative merits of the lock versus sea-level canal must rest upon the ease and safety of navigation offered by the two types.

In the sea-level type offered in lieu of the lock type already described, the Chagres River is controlled by a masonry dam across the valley at Gamboa 4,500 feet long, 750 feet of which is subject to a pressure due to a head of 170 feet during the extreme flood stages of the river. Proper sluice gates are proposed for discharging the river into the canal. The difference in tides is overcome by means of a lock on the Pacific side in the vicinity of Sosa Hill. While provisions are made for damming or diverting some of the streams that would otherwise enter the canal prism, not less than 22 flow directly into the canal, with no provision to control the currents or check the deposits of material carried by them during flood stages.

The prism of the canal is to have a bottom width of 150 feet through the earth sections, or for nearly one-half its length, and a 200-foot bottom width through the rock sections. Nineteen miles of the length are made of curves so that the proposed sea-level canal is not a wide, straight, and open channel, connecting the two oceans, but a narrow tortuous ditch, with varying currents of unknown strength, impeded by a lock, and threatened by a dam resisting a pressure due to a head twice as great as that at Gatun.

To be sure, the partisans of the sea-level type are now proposing to eliminate both the Gamboa Dam and the tidal lock by making the channel so wide as to reduce the currents that result from the discharge of the Chagres and the difference in tides, but fail to explain how they purpose to control or divert the Chagres, the bed of which will be 50 feet above the water surface of the canal at the juncture. As data is not available for preparing accurate estimates for even such a sea-level type as was originally offered, neither they nor any one else can offer any figures as to time and cost for the construction of such a canal as they now advocate.

In any comparison, therefore, we must confine our attention to the lock type as now building, and a sea-level canal as offered by the board of engineers, and not by the idealist.

So far as the two prisms are concerned, for ease and safety of navigation the lock type is better because of the greater widths of channels, fewer and easier curves, and freedom from objectionable and troublesome currents, both from the Chagres and its tributaries. This must be admitted by all, but the exponents of the sea-level type concentrate their attention on the obstructions and dangers that the locks constitute in the lock type, and also on the dangers that will result from the failure of the Gatun dam, forgetting that at least equally great disaster must follow the failure of the Gamboa dam. The lock in the sea-level canal is not mentioned, probably because the danger is not so great, since there is but one.

Experience shows that the risks to ships in narrow waterways are material and important. In such a channel as the original Suez Canal the delays and losses to commerce were great, and the danger to ships considerable; although the benefit of the widening is striking, this is true even now.

It is well known that the narrow channels connecting the Great Lakes have been obstructed repeatedly by vessels aground or wrecked in such a manner as to block traffic. Even in the entrances to our seaports there is a frequency of accidents, which illustrate the difficulties encountered in navigating narrow and tortuous channels.

Accidents in locks have been relatively few, and none of a serious nature have occurred at the St. Marys Falls Canal during fifty-four years of its use. The risks to ships in such a narrow waterway, as proposed for the sea-level canal at Panama, far outweigh all hazards in the proposed lock canal, PROVIDED the latter is built so as to minimize the chance of accident at the locks. This is met by providing every possible safety device, by building the locks in duplicate and by the installation of a system by which the vessels will be controlled by powerful electric machinery on the lock walls, thus avoiding mistakes on the part of the vessels' crew or engine-room staff, which once led to an accident at the Manchester Ship Canal.

Again, it is objected that the size of the locks limits the canal to vessels which can use them. This is true. The present lock designs provide intermediate gates dividing the locks into lengths of 600 and

400 feet. About 98 per cent of all the ships, including the largest battle ships now building. can be passed through the 600-foot lengths, and the total lock length will accommodate the largest commercial vessels now building, which, I believe, are 1,000 feet long and 88-foot beam.

It is true that ships may increase in size so as to make the present locks obsolete, but the largest ships now afloat can not navigate the present Suez Canal, nor the proposed sea-level canal at Panama. It must also be remembered that the commerce of the world is carried by the medium-sized vessels, the length of only one of the many ships using the Suez Canal being greater than 600 feet.

The General Board of the Navy is on record that 110 foot width will be ample for the future needs of the Navy, and naval construction of the future will be limited not alone by the locks of the Panama Canal, but also by the available dry docks. Ships that can not use locks 1,000 feet by 110 feet can not use a 150-foot sea-level canal, nor can this be so easily and economically increased and maintained as is made to appear by its advocates.

Increasing the width of Culebra cut, as recently ordered, from 200 to 300 feet is advanced as an argument to show that the locks are too narrow. Ships do not navigate the locks in the sense that they do the canal prism, and the wider the channel the easier will be navigation. On account of slides that developed in Culebra cut considerably more additional work was made necessary in the upper reaches of the divide than was contemplated, and the advantages of the increased width to navigation were so great, compared with the relative amount of material to be removed in order to secure it, that the President ordered it. By this action the width of the locks is in nowise called into question.

The water supply for lockages was so exhaustively treated by the minority of the board that it has not been called into question by anyone who has carefully considered the report and data submitted therewith. Recently, however, the theory has been advanced that the water of the lake may seep through the adjacent hills or through the bottom, and is significantly referred to as a mooted question. This possibility is emphasized by the seamy quality of the rock when exposed. The French plans, with Bohio Lake, were the result of careful and protracted study and investigation, and nothing of the kind was anticipated. The commission of 1901 was not in doubt of the resisting power of the hill covering such a flow. The report of the geologist on the general formation of the country does not lead to any such dread or fear. The reservoirs, constructed in the hills of the same geological formation as the entire lake area, are not affected by any such leakage or seepage. At Black Swamp, an extensive area between Bohio and Gatun, the water stands above the level of the Chagres—which is within half a mile—and also above sea level the level of the water remains unchanged, clearly indicating no such leakage.

Toward the close of the last dry season certain measurements of the Chagres at Bohio indicated a less discharge there than at Gamboa; this was subsequently exploded by other observations which showed that the first ones were in error. Notwithstanding this, and in spite of the many evidences of the tightness of the earth covering, the possibility of a flow through the hills was advanced and was seized upon as another argument against the lock type.

The Board of Consulting Engineers estimated the cost of the lock type of canal at $139,705,200, and of the sea-level canal at $247,021,000, excluding the cost of sanitation, civil government, the purchase price, and interest on the investment. These sums were for construction purposes only.

I ventured a guess that the construction of the lock type of canal would approach $300,000,000, and without stopping to consider that the same causes which led to an increase in cost over the original estimates for the lock canal must affect equally the sea-level type, the advocates of the latter argued that the excess of the new estimates was an additional reason why the lock type should be abandoned in favor of the sea-level canal.

The estimated cost by the present commission for completing the adopted project, excluding the items let out by the Board of Consulting Engineers, is placed at $297,766,000. If to this be added the estimated cost of sanitation and civil government until the completion of the work, and the $50,000,000 purchase price, the total cost to the United States of the lock type of canal will amount to $375,201,000. In the preparation of these estimates there are no unknown factors.

The estimated cost of the sea-level canal for construction alone sums up to $477,601,000, and if to this be added the cost of sanitation and civil government up to the time of the completion of the canal, which will be at least six years later than the lock canal, and the purchase price, the total cost to the United States will aggregate $563,000,000. In this case, however, parts of the estimate are more or less conjectural—such as the cost of diverting the Chagres to permit the building of the Gamboa dam and the cost of constructing the dam itself. Much has been said of the disadvantage of the seamy rock in connection with some experiments made at Spillway Hill test pit and of the so-called "indurated clay," yet these same disadvantages apply to the foundation at Gamboa and the same class of material must be dealt with. The cost of constructing and maintaining a channel through the swamps of the lower Chagres is an unknown factor, and no schemes have been developed for controlling the various streams that are encountered and that must be reckoned with along the route of the canal. So that the sea-level estimates have not the accuracy of those for the lock type.

The majority of the Board of Consulting Engineers estimated that from ten to thirteen years would be required for the completion of the sea-level canal. The Isthmian Canal Commission and the then Chief Engineer fixed the time from eighteen to twenty years. It will take at least six years to complete the dam at Gamboa, and until the control of the Chagres River is assured, little if any excavation can be carried lower than 40 to 50 feet above sea level, so that in the absence of anything more definite the time needed to construct the Gamboa dam is assumed as the additional period needed for completing the sea-level type.

Much criticism has resulted because of the excess of the present estimates over those originally proposed, arising largely from a failure to analyze the two estimates, or to appreciate fully the actual conditions.

The estimates prepared and accompanying the report of the consulting engineers were based on data less complete than are available at present. The unit costs in the report of 1906 are identical with those in the report of 1901, and since 1906 there has been an increase in the wage scale and in the cost of material. On the Isthmus wages exceed those in the United States from 40 to 80 per cent for the same class of labor. The original estimates were based on a ten-hour day, but Congress imposed the eight-hour day. Subsequent surveys and the various changes already noted have increased the quantity of work by 50 per cent, whereas the unit costs have increased only 20 per cent—not such a bad showing. In addition, municipal improvements in Panama and Colon, advances to the Panama Railroad and moneys received and deposited to the credit of miscellaneous receipts aggregate $15,000,000, which amount will eventually and has in part already been returned to the Treasury. Finally, no such system of housing and caring for employees was ever contemplated as has been introduced and installed, materially increasing the overhead charges and administration.

Much stress has been laid upon the fact that recent improvements in machinery have so modified conditions that the excavation can be done more economically by special devices in conjunction with dredging than is possible with the methods now adopted. The machines referred to are for shattering rock under water, and though it is claimed that such devices have given satisfactory results in connection with the Manchester Ship Canal, it is known that similar appliances have failed in certain localities in the United States where they were tried. The variations in the character of the rock on the Isthmus from soft argillaceous sandstone to hard trap are such as to make the use of such devices very problematical. Experience generally has shown that more money can be wasted on subaqueous rock excavation than in the removal of such material in the dry. Experiments are now being made on the Isthmus with one of these rock-crushing devices, but thus far the results are not promising.

Much has been written recently concerning the probable effect of earthquakes. The last earthquake of any importance occurred in the seventeenth century, and existing ruins in Panama demonstrate clearly that no shock of any violence could have occurred during the eighteenth or nineteenth centuries. Should an earthquake visit the Isthmus the chances are that the effect upon the Gatun dam would be less disastrous than upon the Gamboa dam. The solid concrete construction of the locks, strengthened by reenforcements, will be as proof against any earth shocks as any structure which man builds anywhere, and the sea-level canal has as much to fear as the lock canal.

The vulnerability of the lock canal in time of war is another argument advanced in favor of the sea-level type, but has little weight, as the sea-level type is equally vulnerable from attacks by land or air in its Gamboa dam as are tidal locks and the various devices for controlling the streams along the route.

The idea of the sea-level canal appeals to the popular mind, which pictures an open ditch offering free and unobstructed navigation from sea to sea, but no such substitute is offered for the present lock canal. As between the sea-level and the lock canal, the latter can be constructed in less time, at less cost, will give easier and safer navigation, and in addition secure such a control of the Chagres River as to make a friend and aid of what remains an enemy and menace in the sea-level type.

In this connection attention is invited to the statement made by Mr. Taft, when Secretary of War, in his letter transmitting the reports of the Board of Consulting Engineers:

> We may well concede that if we could have a sea-level canal with a prism of 300 to 400 feet wide, with the curves that must now exist reduced, it would be preferable to the plan of the minority, but the time and cost of constructing such a canal are in effect probibitive.

We are justly proud of the organization for the prosecution of the work. The force originally organized by Mr. John F. Stevens for the attack upon the continental divide has been modified and enlarged as the necessities of the situation required, until at the present time it approaches the perfection of a huge machine, and all are working together to a common end. The manner in which the work is being done and the spirit of enthusiasm that is manifested by all forcibly strikes everyone who visits the works.

The main object of our being there is the construction of the canal; everything else is subordinate to it, and the work of every department is directed to the accomplishment of that object.

In addition to the department of construction and engineering, there are the departments of sanitation and civil administration, the quartermaster's and subsistence departments, the purchasing department organized in the United States, the legal department, and the departments of examination of accounts and disbursements. Subordinated to, but acting in conjunction with, the commission is the Panama Railroad.

Too much credit can not be given to the department of sanitation, which, in conjunction with the division of municipal engineering, has wrought such a change in the conditions as they existed in 1904 as to make the construction of the canal possible. This department is subdivided into the health department, which has charge of the hospitals, supervision of health matters in Panama and Colon, and of the quarantine, and into the sanitary inspection department, which looks after the destruction of the mosquito by various methods, by grass and brush cutting, the draining of various swampy areas, and the oiling of unavoidable pools and stagnant streams.

According to the statistics of the health department, based on the death rate, the Canal Zone is one of the healthiest communities in the world, but in this connection it must be remembered that our population consists of men and women in the prime of life, with few if any of the aged, and that a number of the sick are returned to the United States before death overtakes them.

To the sanitary department are also assigned 11 chaplains employed by the commission to attend the sick, as well as to look after the spiritual welfare of the employees. At most of the villages there is a combined church and lodge house so constructed that the lower floor is used for divine service, while the upper part provides places for meetings of the various lodges. The assignment of time to ministers and to lodges is made by the quartermaster's department.

The department of civil administration exercises supervision over the courts, which consist of three circuit and five district judges; the three former, sitting *in banc,* constitute the supreme court. The district courts take cognizance of all cases where the fine does not exceed $100 or imprisonment does not exceed thirty days. Jury trials are restricted to crimes involving the death penalty or life imprisonment—in short, summary justice rules, and so long as the zone is nothing more nor less than a construction camp this form of law or justice will continue to be the most satisfactory.

The department of civil administration has charge also of the police force, the post-offices, collection of customs and taxes, the issue of licenses, and the public-school system. The schools are improved to such an extent that the children of the employees have very nearly the same advantages as in the United States up to and including the high-school courses.

The quartermaster's department has charge of the recruiting of labor, the care, repair, and maintenance of quarters, the collection and disposal of garbage and refuse, the issue of furniture, and the delivery of distilled water and commissary supplies to the houses of employees, and is to have charge of the construction of all new buildings. Operating in conjunction with the purchasing department in the States, the quartermaster's department secures all supplies needed for construction and other purposes and makes purchases of materials on the Isthmus when required.

The common-labor force of the commission and the Panama Railroad aggregates in the neighborhood of 25,000 men, and consists of about 6,000 Spaniards, with a few Italians, the remainder being from the West Indies. The Spaniard is the best laborer, as he possesses more strength and endurance. Under some conditions this is not true, the foreigner strenuously objecting to doing work that requires him to stand in water.

All the skilled labor, the clerical force, and the higher officials are Americans and are recruited through the Washington office.

This department also has charge of all the property records, receives semiannual returns of property from all those to whom property has been issued, and checks the returns and inventories of the storehouses, made at certain times, with the records compiled from original invoices.

The subsistence department has charge of the commissaries and the manufacturing plants which consist of an ice and cold-storage establishment, a bread, pie, and cake bakery, a coffee-roasting outfit, and a laundry. These belong to the Panama Railroad Company, as, at the time they were established, money received from sales could be reapplied, whereas if operated by the commission the money would have reverted to the Treasury, necessitating reappropriation before the proceeds of sale could be utilized. They are, however, under the management of the subsistence officer of the commission, who has charge of the various hotels, kitchens, and messes of the commission.

There are 16 hotels from Cristobal to Panama, which serve meals to the American, or gold, employees at 30 cents per meal. There are 24 messes where meals to European laborers are served, the cost per day to such laborers being 40 cents; and there are 24 kitchens, or messes, for meals supplied to the silver laborers, or West Indians, the cost to the laborer being 30 cents per day for 3 meals. Subsistence is furnished without profit to the commission, though every effort is made to have the institutions self-supporting. The commissaries and manufacturing plants are operated at a profit so as to reimburse the Panama Railroad Company for its outlay in six years from January 1, 1909, at 4 per cent interest.

The subsistence department also has charge of the Hotel Tivoli, which is a large hotel located at Ancon, for the entertainment of the commission's employees at a comparatively low rate, and of transient guests at rates usually charged at first-class hotels.

All moneys are handled by the disbursing officer, who pays accounts that have been previously passed upon by the examiner of accounts. This last-named official makes the administrative examination required by law prior to the final audit of the accounts by the Auditor for the War Department. The pay rolls are prepared from time books kept by foremen, timekeepers, or field clerks, subsequently checked by the examiner of accounts, who maintains a force of time inspectors. The time inspectors visit each gang, generally daily, at unknown times to the foreman, timekeeper, or field clerk, and check the time books with the gangs of workmen; the inspectors report to the examiner of accounts the results of their inspection not only in connection with timekeeping, but all violations of the regulations of the commission that may come under their observation.

Payments of pay rolls are made in cash, beginning on the 12th of each month and consuming four days for the entire force on the Isthmus. All American employees and European laborers are paid in gold; all on the so-called "silver roll" are paid in Panamanian silver.

The department of construction and engineering is under the direct charge of the Chief Engineer. He is assisted by the Assistant Chief Engineer, who considers and reports upon all engineering questions submitted for final action. The Assistant Chief Engineer has charge of the designs of the locks, dams, and spillways, and supervision of these particular parts of the work. There is attached to the Chief Engineer an assistant to the chief engineer, who looks after mechanical forces on the Isthmus, and has supervision over the machine shops, the cost-keeping branch of the work, the apportionment of appropriations, and the preparation of the estimates. There is also an assistant engineer, who has charge of all general surveys, meteorological observations, and river hydraulics.

The zone is divided territorily into three divisions, each in charge of a division engineer, the first extending from deep water in the Caribbean south to include the Gatun locks and dams, known as the

"Atlantic division." The second, or "Central Division," extends from Gatun to Pedro Miguel, and includes the excavation through the continental divide. The third, or "Pacific Division," extends from Pedro Miguel, including the locks and dams of that locality, to deep water in the Pacific.

The general plans emanate from the office of the Chief Engineer and the details are left to division engineers, subject to the approval of the Chief Engineer. The whole idea of the organization in the Department of Construction and Engineering, and in fact of all the work, is to place and fix responsibility, leaving to each subordinate the carrying out of the particular part of the work intrusted to his charge.

Each division engineer has charge not only of the work involved in the construction of the canal, but all municipal engineering, including water supply, building and maintaining roads, and the establishment and maintenance of sewer systems. With the force under his charge the division engineer executes such sanitary draining as may be prescribed by the chief sanitary officer, so that all construction work, excepting the construction of buildings, concerning the location of which the division engineer is consulted, however, is directly in the hands of the division engineer.

Attached to the office of the chairman is a general Y. M. C. A. secretary, who has supervision of the commission's clubhouses, which are operated and maintained under the auspices of the Y. M. C. A. Four of these are now constructed and in operation, and four more are to be built from funds recently made available by Congress. They have done much toward securing a greater permanency to the force, in giving healthful amusement, and to a better contentment on the part of the employees.

I have endeavored to show that a channel of sufficient width, in which the waters of the many streams, especially the Chagres, will not be a menace, is one most desired for an Isthmian canal. The sea-level canal proposed by the majority of the Board of Consulting Engineers is not of sufficient width, nor is the proposed solution for the impounding and diversion of the Chagres and other streams based upon sufficient investigations to insure its success. The "ideal" sea-level canal, the Straits of Panama, recently proposed, is not based upon any investigations of the work to be done and can not, in view of the approximate estimate of the cost of our own sea-level canal, which is about one-third the size of the "ideal" plan, be given serious consideration. Every criticism against the stability of our locks or dams can be attributed to either an argument in favor of one's own plans or to absolute ignorance of the exhaustive data concerning their safety now in existence. The several other plans of lock-type canal have nothing in their favor that the plan now adopted does not possess to a greater degree.

I have endeavored also to show that the organization on the Isthmus is compact and complete in every way, performing its duties of construction, sanitation, and government with clocklike precision. I can not do better than quote from the message recently sent to the Congress, "that hereafter attack on this type—the lock type—is in reality merely attack upon the policy of building any canal at all," for the adoption of a sea-level canal anywhere approaching the ease of navigation of the lock type will result in the ultimate abandonment of the canal; and I assure you that several years hence, no later than January 1, 1915, even the most ardent sea-level advocates will, in making the voyage through the canal, admit that the ability to navigate a battle ship at a high rate of speed through the lake and wide channel from Gatun to Pedro Miguel far outweighs the small inconveniences of the safe lockages up to and down from the summit level.

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A DEFENSE
OF THE
PANAMA ROUTE

BY

PROF. ANGELO HEILPRIN, F. R. G. S.,

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American Philosophical Society, of the Board of Managers of the
National Geographic Society of Washington, of the
Geological Society of America, etc.

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A DEFENSE OF THE PANAMA ROUTE.

BY

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The final report (Senate Document No. 54, 1901) of the Isthmian Canal Commission so manifestly sets forth the engineering advantages of the Panama Canal route, while giving a decision in favor of the Nicaragua route, that it is no longer necessary to enter upon a discussion of this phase of the canal problem. Aside, however, from conceding what had been very generally known to engineers before the Commission came into existence, and furnishing a valuable summary of the work made in the field by its special experts (the details of which are published elsewhere), the report is singularly defective in some of its particulars, and will be judged by many to emphasize largely, or even wholly, erroneous conclusions. These conclusions touch not so much important questions in engineering as they do those of geography (commerce) and geology.

THE SHORT COMMERCIAL ROUTE.

It will be seen that this report says: "For the commerce in which the United States is most interested, that between our Pacific ports and Atlantic ports, European and American, the Nicaragua route is shorter by about one day.

The same advantage exists between our Atlantic ports and the Orient" (p. 260). While it may be easily denied, in view of the rapid development of trade with South America and the fact that the transcontinental railroad lines will always be competitors in freight carriage to and from the vast interior of the national domain, that the canal commerce in which the United States is most interested is that which links the eastern and western ports of our own country, the *error* of the conclusion that for this commerce the Nicaragua route is shorter by about one day cannot be questioned. The Commission affirms that the estimated time for a deep-draft vessel to pass over the contemplated Panama route is 12 hours, and over the Nicaragua route—the longer by 134.57 miles—33 hours, giving the advantage of 21 hours to the Panama route. Applying this advantage to steamers of different sailing powers, to those of 13 knots, 15 knots, and 20 knots (cruisers), we obtain as profit to the vessels using the Panama route 139, 181, and 286 knots respectively. The U. S. Hydrographic Office furnishes the data regarding the different sailing routes, and gives an actual saving in distance (between New York and San Francisco) by the use of the Nicaragua route of 377 miles. Therefore, the net gain by the Nicaragua traverse would be this amount *less* the loss in making the long isthmian journey: 238 miles (or 18.3 hours) for the 13-knot steamers; 196 miles (or 13 hours) for the 15-knot steamers, and 91 miles (or 4.5 hours) for the 20-knot cruisers. A consideration of a 10-knot speed, which appears to underlie the result obtained by the Commission, may be interesting, but is hardly of value in the determination of canal construction, since it is certain, with the rapid development of speed-power, that but few vessels entering as competitors for freight in an extended ocean course will in the future be constructed with a speed-power of less than 14 or 15 knots.

The conditions in regard to the course to the Orient are still more favorable to the Panama route, for the saving in actual distance via Nicaragua, as the data of the Hydrographic Office show, is only 255 miles. Therefore, steamers of 13 knots using the Nicaragua route would have the advantage over the Panama steamers of only 9 hours (116 miles) in the course to Yokohama and Shanghai; and those of 15 knots, of only 5 hours (74 miles). The swift-flying cruiser of 20 knots would, on the other hand, lose 1½ hours (31 miles). In the course to Australia the advantage would lie with the Panama route. It is needless to say that these slight differences of disadvantage or advantage, over courses of 5,000 and 10,000 miles length, practically parallel the two routes. The conditions are, however, *wholly* different when the course with the western ports of South America is considered, and concerning which the Commission reports: "For commerce between North Atlantic ports and the west coast of South America the Panama route is shorter by about two days" (p. 261)—*a saving of two days in a traverse (to Guayaquil) of only 2,900 miles!*

In this determination of travel-time the figures given by the Isthmian Canal Commission for the traverse of the two routes have been accepted merely for the purpose of presenting the problem in the most favorable aspect taken from the viewpoint of the Commission. It is, however, positively certain that if the average passage over the Panama route is to be taken at 12 hours, no vessel would or *could* make the average Nicaragua passage—longer by 134 miles, with a considerably higher summit level, and through a canal with twice the number of locks with much more rapid curves—in 33 hours. It is not alone the question of actual sailing time, but that of delays, which has to be taken into account into the resolution of traverse-time; and it is needless to say that over a long canal course the possibilities (certainties) of delays of different kinds are accentuated in a very different degree from what they would be over a short canal course. It can reasonably be accepted that 40 hours would more nearly represent the actual traverse of the Nicaragua Canal than 33 hours. With this time allowance the Panama Canal would be made the virtual equal of the Nicaragua Canal even in the trade route between our Atlantic ports and the Pacific ports of the United States, for a 15-knot steamer traversing it would only lag 77 miles (5.1 hours) of its Nicaraguan competitor in the voyage to San Francicso, while a 20-knot cruiser would be in advance by 63 miles (3.1 hours).

It is manifest, therefore, that with practically no saving advantage to either route in the course to the western coast of the United States and the ports of the Orient, and with a most marked advantage to the Panama route in the course to the western coast of South America, the *true commercial isthmian route is that of the Panama Canal.*

THE DANGER FROM VOLCANIC DISTURBANCES.

In its Preliminary Report, submitted to Congress in December, 1900, the Isthmian Canal Commission is silent on the subject of the dangers from earthquake and volcanic disturbances to which the Nicaraguan Canal would be subject, manifestly considering as satisfactory the report of the Geologist of the Nicaragua Canal Commission (whose labors practically excluded this field of inquiry) confirming the report of the earlier geologist employed by the Maritime Canal Company that the risk of serious injury was "so small that it ought to be neglected alike by the Maritime Canal Company, the Construction Company, and by contemplating investors." It is probably on the strength of this opinion that the Nicaragua Canal Construction Company, in their brochure on "The Inter-Oceanic Canal of Nicaragua" (1891), exultingly refers to the "grand old" cathedral of Leon as having "for more than a century and a half . . . stood the vicissitudes of earthquake, weather, war, piracy, revolution, and its walls are still solid and unshaken," and define the risk of injury to Nicaragua Canal construction by earthquakes as existing only "in the theories of those who are interested in the making a canal at some other locality or in the mind of the man who is naturally a pessimist and opposed to all bold undertakings." This vain-glorying was, however, rebuked in less than a decade, for, on April 29, 1898, a violent earthquake, which agitated the whole of Nicaragua, and had its greatest intensity in the plain of Leon, destroyed (as we are informed in the report of the Government Technical Commission of Nicaragua) 340 houses in the city of Leon, besides inflicting considerable damage elsewhere. Even the "grand old" cathedral had its walls and cupolas rent with cracks.

In its present final report, the Isthmian Canal Commission finds it necessary to enter into a brief discussion of this subject, which, indeed, might be considered to be rather an apology for a discussion than a discussion itself. Little sympathy can be had for a report which dismisses this all-important topic in hardly more than three pages, and uses as its main argumentative text Humboldt's *Cosmos*, the first American edition of Lyell's *Principles of Geology*, the second edition of Daubeny's *Volcanoes*, and the fragmentary (and confessedly incomplete) list of earthquakes prepared by Montessus de Ballore. The sciences of vulcanology and seismology have made such rapid advances during the last quarter of a century that one wonders how reference can be made to these works for "authority"; nor is it more intelligible how Humboldt's earliest conception of the relation of the mountain systems of the two continents, which Humboldt himself quite gave up upwards of forty years ago, can be taken as the modern guide in the study of the region in question. We are told that a glance at the map appended to the report will show "that the entire isthmus between North and South America is a volcanic region," and, following Humboldt, that "the grandest example of a continental volcanic 'chain' is offered by the great rampart of the Andes extending from the southern part of Chile to the northwest of America" (p. 168). It has, however, been known for a full quarter of a century that the main Andes do *not* traverse the Isthmus of Panama, and that there are no active or recently decayed volcanoes in any part of the true isthmus. So far, therefore, as danger from direct volcanic contacts is concerned, the Panama route is exempt. The case is very different with the Nicaragua route, whose line is laid across the almost continuously volcanic tract that binds Costa Rica with Salvador, and which has been, during the period of the last three-quarters of a century, probably the most violently eruptive of any in the Western Hemisphere. On the line of crustal weakness that is occupied by Lakes Nicaragua and Managua there are distributed over a linear distance of little more than 200 miles not less than 25 volcanoes, most of which have been active within a very modern period of time, while a number are still active to-day. A few actually lie within the basin of Lake Nicaragua itself. Coseguina, which lies only 60 miles distant from the line of the initially-proposed canal, went through a paroxysm in 1835 which has been described by the Geologist of the Nicaragua Canal Commission as "the most violent recorded eruption until surpassed by that of Krakatoa in 1883." Yet, in the face of these facts, known to all geographers and geologists, the Isthmian Canal Commission would have us believe that so far as danger from this source is concerned the two routes stand equal!

It is not a little surprising that the only source of danger that the Commission associates with volcanic manifestations is that dependent upon the secondary phenomena of earthquakes. The individual volcanic catastrophe, as such, does not enter for consideration; and yet it is only fifteen years ago (1886) that the great Lake of Rotomahana, in New Zealand, was wrecked and emptied of its water through the eruption of a volcano (Tarawera), thought to have been extinct for upwards of a hundred years! And only a few years earlier (1879-80), the waters of Lake Ilopango, in Salvador, had been lowered 35 feet as the result of an eruption in that body of water. The physiographic conditions of Rotomahana previous to 1886 could have been precisely paralleled with those now existing about the lake region of Nicaragua.

THE CONDITIONS OF EARTHQUAKE PHENOMENA.

It is difficult to comprehend the conclusion arrived at by the Isthmian Canal Commission regarding the dangers to be feared from earthquake disturbances. Were the subject not so important a one, a geologist might be led to assume that the discussion as it is presented was not intended to be treated seriously. We are told that in general terms "the region of volcanoes is the region of earthquakes, but the immediate vicinity of the volcanoes is not necessarily the most dangerous part of the region"—a statement that is presumably intended to carry with it the inference that the region of Panama, which is distantly removed from volcanoes, is about as likely to suffer from earthquake disturbances as the region of Nicaragua, which is in close proximity to or in direct association with volcanoes! The basis of this singular conclusion appears to be the "doctrine," "accepted by such writers as Baron Von Humboldt, Sir Charles Lyell, Prof. Charles Daubeny, and J. Le Conte," that volcanoes are "safety valves which diminish the violence of earthquakes in their vicinity" (p. 167)! One can readily admit that were it not for the presence of active volcanoes certain earthquakes in particular regions would be more destructive than they have actually shown themselves to be, but this in no way affects the general proposition that earthquakes centre about the volcanoes. While it is perfectly true that many and even very destructive earthquakes, such as those of Lisbon, in 1755, and Charleston, in 1886, have taken place in absolutely non-volcanic regions, and will repeat themselves as such in the future, it is equally true that every region of marked volcanic activity, or crustal weakness, is one distinguished by earth-movements and dislocations. The Costa Rican-Nicaraguan-Guatemalan region is one preëminently of this class, and one need have no more impressive testimony to this condition than the destruction, either complete or in large part, of the town of

Cartago, in Costa Rica, four times in the course of the past century (1803, 1841, 1851, 1854), the destruction ten times of San Salvador and seven times of the city of Guatemala. The town of Rivas, at the precise outlet of the proposed Nicaragua Canal from Lake Nicaragua, was almost completely destroyed by the earthquake of 1844, which also wrecked considerable damage to Greytown, the inlet to the proposed canal. Mr. E. G. Squier, former Chargé d'Affaires of the United States to the Republics of Central America, describing the earthquake of 1844, states that the waters of Lake Nicaragua "were observed to rise and fall with the throes of the earth."

It is well known, and the fact is admitted in the report of the Isthmian Canal Commission, that the only recorded earthquake on the Panama tract "that could be called destructive," in a period of over three centuries (or from the time of the Spanish Conquest to the year 1886), was the earthquake of 1621, which destroyed the greater part of Panama. It is, therefore, surpassing strange, with these convincing facts before it, that the Commission should not find it possible "to justify a comparison between the Nicaragua and Panama routes as to either the number of earthquakes or their severity" (p. 168). The recent shocks reported from Greytown must add to the embarrassment in drawing a conclusion. Were the volcanic "safety-valves" not present, it would, perhaps, be easier to resolve the question; but, then, it might pertinently be asked, What was Vesuvius doing during the great Neapolitan earthquake of 1857? What, again, was it doing in 1886, when the city of Casamicciola, on the Island of Ischia, was wrecked, or what was the function of Etna, at the time of the destruction of Catania, in 1693?

What was the particular aid that the volcano of Irazú, in Costa Rica, gave to the town of Cartago, lying near its base, when it was wrecked in the years 1803, 1841, 1851, and 1854—or that which the Volcan de Fuego gave to the ancient city of Guatemala? These instances and others that might be cited almost without number, ought to be sufficient to convince all who are not particularly interested in canal constructions that the presence of an active volcano is no safeguard or "mitigating circumstance" in the calculation of earthquake possibilities. Its presence, on the contrary, is a warning signal forever, for the conditions that brought it into existence are the very ones that make earthquakes, of one class at least.

THE WATER SUPPLY OF LAKE NICARAGUA INSUFFICIENT FOR THE NICARAGUA CANAL.

In earlier papers on the water supply of Lake Nicaragua attention is called to the surprising fact, developed by the investigations of the Nicaraguan and Isthmian Canal Commissions, that, if these investigations are accurate and to be relied upon, the water in the lake must be a continuously diminishing one, since the San Juan River and the general evaporation from the surface of the lake remove more than the annual rains supply to the lake basin. This conclusion, pertinent to the question of the instability and steady abasement of the lake level, and its effect upon a canal requiring a permanent summit level, has been warmly dissented from by the Geologist and Hydrographer of the Commissions. In its present report, however, by accepting the impugned or presumably unreliable data of rainfall made at Rivas and Masaya, and the observations on evaporation made by its

Chief Hydrographer, the Commission virtually assumes the condition, and finds it necessary to throw out the warning that "no wastage whatever would be permitted during such a low-water wet season as that of 1890. The rainfall from the entire drainage basin would be impounded in the lake, and it would then fall short of restoring the depletion resulting from evaporation and requirements of the canal" (p. 146). As a result of the operations of the nineteen months of that particular season (calculating from November, 1889, to June, 1891), the Commission says: "In other words, in spite of all storage of available water during the nineteen months, evaporation from the lake and the use of the canal have run the elevation of the lake surface down from 110.2 to 104 (feet), representing the net depletion of 6.2 feet in depth of lake water" (p. 153).

The menace to a permanent canal from a condition of this kind—the loss of its water—is so serious that only the most conclusive evidence as to the non-recurrence in successive periods of low water should be accepted as proving the "recovery" of the lake in the alternate wet periods. The Commission appears to have satisfied itself on this point, for in its report it says: "The entire record for fifteen years, from 1886 to 1900, at Granada and Masaya, shows but one year, 1890, with insufficient precipitation during the rainy season to fill the lake and restore the amount evaporated" (p. 154). This conclusion is *not* borne out by the data that are supplied in the special reports of the Chief Engineer and the Chief Hydrographer. It is shown, for example, that between the months of November, 1893, and May, 1897, the total rainfall was at Rivas 192 inches (and at Masaya 133 inches), which according to the formula furnished by the Chief Engineer of the Nicaragua Canal Commission, would have raised the surface of the lake, were there no outflow and no evaporation, by almost exactly 200 inches. The evaporation during the same period of three and a half years, as computed by the Chief Hydrographer, would be 210 inches—a loss to the lake, therefore, of 10 inches, *allowing not a particle of overflow with which to supply the canalized river, and not permitting a drop of wastage of any kind.*

Precisely the same condition presented itself in the interval from November, 1882, to May, 1886, and our knowledge is much too imperfect to permit us to say with any degree of positiveness that much more unfavorable conditions may not present themselves in the future.

The facts in our possession, then, manifestly, do *not* justify the conclusion of the Commission that the "lake affords an inexhaustible water supply for the canal" by the Nicaragua route (p. 257). They show plainly the reverse: that the supply is insufficient, and that no amount of storage or raising to high level compatible with the security of the construction and general convenience can give sufficient margin of "retained" water to insure a serviceable canal.

CONCLUSION.

The broad conclusions that can be drawn from all the premises are:—

1. Commercially, the true trans-isthmian route is that of the contemplated Panama Canal.

2. Constructionally,—as involving less engineering difficulties, avoiding the superior risks from earthquake and volcanic disturbances and water shortages, and presenting a far more acceptable course for steaming,—the Panama Canal, of the two canals under general discussion, alone merits serious consideration.

THE TRANS-ISTHMIAN CANAL:

A STUDY IN AMERICAN DIPLOMATIC HISTORY

(1825-1904)

BY

CHARLES HENRY HUBERICH, D. C. L.,
Adjunct Professor of Political Science and Law in the University of Texas

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A STUDY IN AMERICAN DIPLOMATIC HISTORY (1825-1904).[1]

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The projected canal across the isthmus joining the two Americas, which has interested the governments of Europe since the discovery of the American continent, played no rôle in the foreign policy of the United States until after the Spanish-American colonies had achieved their independence. In 1825, Señor Antonio José Canaz, the representative of the Central American Republic at Washington, proposed to the United States that the two governments coöperate in the construction of the Nicaragua canal. Señor Canaz was assured of "the deep interest which is taken by the government of the United States in the execution of an undertaking which is so highly calculated to diffuse an extensive influence on the affair of mankind." In addition, Mr. Clay, then secretary of state, instructed the American chargé d'affaires in Central America to collect all data relative to the cost and practicability of the Nicaragua route. The subject aroused considerable interest in commercial circles, and a contract was actually entered into between the Central American Republic and some New York capitalists for the construction of the canal.[2]

The canal project was one of the topics to be discussed at the Panama congress in 1826. In the instructions to the American delegates to that congress the policy of the United States in reference to the canal is announced for the first time. "If the work should ever be executed," writes Secretary Clay, "so as to admit of the passage of sea vessels from ocean to ocean, the benefit of it ought not to be exclusively appropriated to any one nation, but should be extended to all parts of the globe upon the payment of a just compensation or reasonable tolls."[1]

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[1] The greater part of this article was published by the writer early in 1903, in the *Revue du droit public et de la science politique*, Vol. XIX, pp. 193-213. It was subsequently revised and published in the *University of Texas Record*, Vol. V, pp. 247-275, and in the *Bulletins of the University of Texas, Humanistic Series*, No. 1.

[2] Keasbey, *The Nicaragua Canal and the Monroe Doctrine*, p. 143.

A few years later the king of the Netherlands launched his project of a canal across Central America "to be opened on the same terms to all nations."[2] As this was entirely in accordance with the American view, no diplomatic action was taken by the United States, except that the American minister to the Netherlands was instructed to endeavor to obtain for the government or citizens of the United States a majority of the shares of stock in the enterprise, and a share in the monopoly.

On March 3, 1835, the Senate passed a resolution requesting the President to open negotiations with Central America and New Granada in order to secure "forever * * * the free and equal right of navigating such canal to all nations, on the payment of such reasonable tolls as may be established to compensate the capitalists who may engage in such undertaking and complete the work." In conformity with this resolution President Jackson appointed Mr. Charles Biddle to investigate the different routes proposed. Mr. Biddle returned to the United States in September, 1836, and from his report the President was convinced that "the probability of an early execution of any of the projects which have been set on foot for the construction of the communication alluded to is not so great as to render it expedient to open negotiation at present with any foreign government upon the subject."[3]

On March 2, 1839, a similar resolution was adopted by the House of Representatives, which resulted in the sending of another agent to the isthmus, who reported in favor of the Nicaragua route, but did not deem it expedient to undertake the work at the moment, owing to the political situation in Central America.

The concession for "le canal Napoléon de Nicaragua" (January 8, 1845) did not call forth any discussion in the United States. But indirectly we may attribute to it the negotiations with New Granada, which resulted in the treaty of December 12, 1846. The thirty-fifth article of this treaty provides that citizens of the United States shall enjoy all the exemptions, privileges, and immunities concerning commerce and navigation enjoyed by citizens of New Granada; and "that this equality of favors shall be made to extend to the passengers, correspondence, and merchandise of the United States, in their transit across the said territory, from one sea to the other. The government of New Granada guarantees to the government of the United States that the right of way or transit across the isthmus of Panama upon any modes of communication that now exist, or that may be hereafter constructed, shall be open and free to the government and citizens of the United States, and for the transportation of any articles of produce, manufactures, or merchandise, of lawful commerce, belonging to the citizens of the United States; that no other tolls or charges shall be levied or collected upon the citizens of the United States * * * than is, under like circumstances, collected from Granadian citizens. * * * And, in order to secure to themselves the tranquil and constant enjoyment of these advantages, and as an especial compensation for the said advantages * * * the United States guarantee, positively and efficaciously, to New Granada * * * the perfect neutrality of the before-mentioned isthmus, with the view that the free transit from the one to the other sea may not be interrupted or embarrassed in any future time while this treaty exists; and in consequence, the United States also guarantee, in the same manner, the rights of sovereignty and property which New Granada has and possesses over the said territory."[1]

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[1] Mr. Clay to Messrs. Anderson and Sargent, May 8, 1826. Wharton, *Digest of the International Law of the United States*, Vol. III, p. 1. Neither of the delegates was present at the Congress.

[2] The concession was obtained December 18, 1830.

[3] *Messages and Papers of the Presidents*, Vol. III, pp. 272, 273.

In his message to the Senate, submitting this treaty, President Polk says:[2]

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[1] Since June 10, 1848, the date of the exchange of ratifications, the treaty has been subject to twelve months' notice of termination by either party.

[2] *Messages and Papers of the Presidents*, Vol. IV, pp. 512, 513. The treaty was ratified without a dissenting vote, but already in the following year the Committee on Naval Affairs of the House referring to the guaranty of sovereignty says: "This is a very wide departure from our foreign policy hitherto, and its justification is only to be found in the exigency of the case, the overruling necessities of our position with reference to our territories on the Pacific."

On May 10, 1847, the government of New Granada granted to a French company the right to construct a railway across the isthmus of Panama, "In entering into the mutual guarantees proposed by the thirty-fifth article of the treaty, neither the government of New Granada, nor that of the United States has any narrow or exclusive view. The ultimate object * * * is to secure to all nations the free and equal right of passage over the isthmus. If the United States, as the chief of the American nations, should first become a party to this guaranty, it can not be doubted—indeed it is confidently expected by the government of New Granada—that similar guarantees will be given to that republic by Great Britain and France. * * * There does not appear any other effectual means of securing to all nations the advantages of this important passage but the guaranty of great commercial powers that the isthmus shall be neutral territory. The interests of the world at stake are so important that the security of this passage between the two oceans can not be suffered to depend upon the wars and revolutions which may arise among different nations."

The next important step of American diplomacy in regard to the isthmus was the conclusion of the Clayton-Bulwer treaty. Before considering the terms of this treaty, it will be necessary to notice briefly the circumstances that led to its negotiation. On the eastern coast of Central America Great Britain had assumed practically undisputed control. The Mosquito territory had been virtually controlled by Great Britain since 1830. In August, 1841, McDonald, the British superintendent of Belize, acting as regent of the infant "king" of the Mosquitos, had seized San Juan del Norte as part of the territory of Mosquitia, thus placing Great Britain in control of the eastern terminus of the proposed Nicaragua canal. The action of McDonald was not disavowed by the British government, and no attention was paid to the repeated protests of the Central American republics. On the contrary, on June 30, 1847, the British agents in Central America were instructed to communicate to the several states that Great Britain, in the exercise of her ancient protectorate over the Mosquito country,

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and to have the exclusive privilege of operating such railway for a period of ninety-nine years. The French company failing to comply with the terms of the grant, the government granted a concession to an American company for the same period of time. Under this concession the Panama railway was built, and put in operation January 27, 1855.

laid claim to territory as far south as San Juan (Greytown).[1] Nicaragua was notified to evacuate San Juan by January 1, 1848. An appeal to the United States by Nicaragua was of no effect, and on the date mentioned Great Britain took possession of San Juan. In addition, Great Britain was in possession of Belize (British Honduras) and of the Bay Islands. On the western coast Great Britain had seized Tigre Island, in the Gulf of Fonseca, (October 16, 1849), thus commanding also the probable western terminus of the canal.[2] In a word, England was master of Central America.

The acquisition of California by the treaty of Guadalupe-Hidalgo (February 2, 1848), followed almost immediately by the discovery of gold in the new territory, and the consequent rush of population to the gold fields, brought the problem of the isthmian transit in the front rank of public attention in the United States.

Mr. Elijah Hise was appointed chargé d'affaires to the Central American states, with instructions to investigate the British claims to the Mosquito coast, and to enter into commercial treaties with the countries to which he was accredited. His instructions, however, did not extend to the securing of any rights over the transit routes. Nevertheless, with a far-sightedness greater than that of his government, Mr. Hise concluded a treaty with Nicaragua in respect to this latter object (June 21, 1849).

The Hise treaty conferred upon the United States or its citizens the exclusive right to construct a canal through Nicaragua. The United States were to be permitted to erect fortifications and to station troops along the channel. In the event of a war in which either of the parties to the treaty was involved, the canal was to be closed to all vessels of the enemy, as well as to neutrals carrying contraband of war to such enemy. During a war in which neither the United States nor Nicaragua was a belligerent, the canal was to be closed to the war vessels of the belligerents, and to neutrals carrying contraband. In time of peace the canal was to be open to all nations on equal terms. Two free cities, under the "qualified dominion" of Nicaragua, were to be established at the termini of the canal. The United States, on their part, guaranteed to "protect and defend the State of Nicaragua in the possession and exercise of the sovereignty and dominion" over all territory rightfully belonging to it.

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[1] Travis, *The History of the Clayton-Bulwer Treaty*, pp. 36, 37, 42.

[2] *Ibid.*, p. 54.

The new administration of General Taylor disavowed the act of Mr. Hise, recalled him, and appointed Mr. E. G. Squier in his place. The policy of the administration was set forth in President Taylor's first annual message to Congress: "Should such a work (i. e., the trans-isthmian canal) be constructed under the common protection of all nations for equal benefits to all, it would be neither just nor expedient that any great maritime state should command the communication. * * * No such power should occupy a position that would enable it hereafter to exercise so controlling an influence over the commerce of the world, or to obstruct a highway which ought to be dedicated to the common uses of mankind."[1]

Nevertheless, the administration threatened to send the Hise treaty to the Senate unless Great Britain made some concessions. In an interview with Mr. Crampton, the British minister at Washington, Mr. Clayton, secretary of state, stated his objections to the treaty and especially to the "absurd stipulation" which bound the United States to guarantee to Nicaragua the integrity of her territory. Mr. Clayton's plan was as follows: That the United States should abandon the treaty concluded by Mr. Hise, and should propose to Nicaragua, simultaneously with Her Majesty's government, another treaty by which no exclusive advantage was to be conferred on either party, and the object of which should be to guarantee the safety of a company of capitalists to whom a charter should be granted by Nicaragua on reasonable terms. Any other power acceding to the terms of the treaty was to be admitted on equal footing with the original contracting parties.[2]

In the meantime Mr. Squier had obtained a concession from Nicaragua for the Atlantic and Pacific Ship-Canal Company (September, 1849), and concluded a treaty with that government by the terms of which the transit routes were to be open to the United States for all lawful purposes, the United States undertaking to guarantee the sovereignty of Nicaragua over the line of the proposed canal, and to guarantee its neutrality. The Squier treaty was not acceptable to the administration, and was never ratified.[1]

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[1] *Messages and Papers of the Presidents*, Vol. V, p. 16.

[2] Letters of Mr. Crampton to Lord Palmerston, September 15, and October 1, 1849. Senate Executive Document No. 194, 47th Congress, 1st Session, pp. 55 *et seq.*

In the United States popular feeling against England grew more bitter from day to day. In the south Great Britain was disliked on account of her anti-slavery sympathies, and throughout the country the Northwest boundary dispute had inflamed the public mind against England. A "jingo" press and party urged that the British aggressions in Central America would some day stand in the way of the "manifest destiny" of the United States to be lord of the American continent.

Acting under instructions of his government, Mr. Rives, accredited as American minister to France, conferred with Lord Palmerston in September, 1849, upon the subject of the Central American affairs. Mr. Rives informed Lord Palmerston that the United States could not acknowledge the legality of the British claims to the mouth of the river San Juan, and that as regards the canal the United States sought no exclusive or preferential right of any kind; that it was their sincere wish to see the canal dedicated to the common use of all nations on the most liberal terms, and on a footing of perfect equality; that the United States would not, if they could, obtain any exclusive right or privilege in a great highway which naturally belonged to all mankind.[2]

When Mr. Lawrence arrived at his post in London, late in 1849, he endeavored to induce the British government to join the United States in the guaranty of the Panama canal under the treaty of 1846 between the United States and New Granada, and further to persuade England to enter into a treaty with Nicaragua on a basis similar to the Hise treaty. The withdrawal of the protectorate over the Mosquito country was, however, a *sine qua non* to further negotiations. Lord Palmerston refused to yield this point, and Mr. Lawrence accomplished nothing. Shortly thereafter the negotiations were transferred to Washington, and resulted in the Clayton-Bulwer treaty of April 19, 1850.

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[1] Travis, *The History of the Clayton-Bulwer Treaty*, pp. 66, 67.

[2] Mr. Rives to Mr. Clayton, September 25, 1849. Senate Executive Document No. 27, 32nd Congress, 2nd Session, pp. 20 *et seq.* Mr. Bancroft, the predecessor of Mr. Lawrence, had entered into negotiations with Lord Palmerston, which were, however, suddenly terminated by Mr. Bancroft's recall.

By the terms of this treaty the two governments agreed that "neither the one nor the other will ever obtain or maintain for itself any exclusive control over the said ship-canal; agreeing that neither will ever erect or maintain any fortification commanding the same, or in the vicinity thereof, or occupy, or fortify, or colonize, or assume or exercise any dominion over Nicaragua, Costa Rica, the Mosquito Coast, or any part of Central America." (Art. I.) "Vessels of the United States or Great Britain traversing the said canal shall, in case of war between the contracting parties, be exempted from blockade, detention, or capture by either of the belligerents; and this provision shall extend to such a distance from the two ends of the said canal as may hereafter be found expedient to establish." (Art. II.) By the fifth and sixth articles the contracting parties agreed to guarantee the neutrality of the transit route, and to invite other nations to enter into stipulations with them similar to those which they had entered into with each other. According to the eighth article, the two governments "having not only desired, in entering into this convention, to accomplish a particular object, but also to establish a general principle, they hereby agree to extend their protection, by treaty stipulations, to any other practicable communications, whether by canal or railway, across the isthmus * * * and especially the interoceanic communications, * * * which are now proposed to be established by the way of Tehuantepec or Panama."

The Senate ratified the treaty on May 22, 1850, by a vote of 42 to 11. Among the statesmen who voted in favor of the treaty were Clay, Webster, Seward, and Cass. The ratifications were exchanged at Washington on July 4, 1850.

Before accepting the final exchange of ratifications, the British minister filed a statement in the Department of State at Washington, declaring that "Her Majesty does not understand the engagements of this convention to apply to Her Majesty's settlement at Honduras, or to its dependencies." Upon receipt of this communication Mr. Clayton wrote to the chairman of the Senate Committee on Foreign Relations: "I wish to leave no room for a charge of duplicity against our government, such as that we now pretend that Central America in the treaty includes British Honduras. I shall therefore say to him, in effect, that such construction was not in the contemplation of the negotiators or the Senate at the time of the confirmation." To this Mr. King replied that "the Senate perfectly understood that the treaty did not include British Honduras." But Mr. Clayton was cautioned not "to use any expression which would seem to recognize the right of England to any portion of Honduras."[1]

Contemporary public opinion on the treaty, as reflected in the newspapers of the day, was divided on strict party lines. The anti-administration journals were loud in their denunciation of the treaty. The *New York Herald* (April 24 and 27) thinks that the whole negotiation was based on a gigantic stock-jobbing operation, and that Sir Henry Bulwer was sent to this country by the joint action of England and Spain to effect an agreement which would forever bar the United States from annexing Cuba. On the other hand, the *New York Tribune* and the *Boston Daily Advertiser* (both of April 24) are warm in their praises. "The treaty is everything," says the former, "that the country could ask." The semi-official *National Intelligencer* (April 27) says that the treaty "is such a compact as will reflect lasting honor on the statesmanship, and wise moderation and liberal spirit of the eminent negotiators, and on the governments under and for which they respectively acted." The same division of opinion existed in England. The *Times* (June 13) commends the action of Lord Palmerston in abandoning the exclusive pretensions of Great Britain to the Mosquito Coast. The *Spectator,* on the contrary, observes: "The value of the treaty is enhanced by its apparent impracticability. * * * The canal is secured—*in posse*—which is something. * * * Should there be no canal, the convention will be no more than a stale and cumbersome joke—a device to confer on the 'state of Mosquitia' some importance."

Disputes as to the proper interpretation of the Clayton-Bulwer treaty arose almost immediately, and as early as April 30, 1852, were sought to be settled by the Webster-Crampton treaty. By this convention a reservation was to be set apart for the Mosquitos, and San Juan was to be placed in the possession of Nicaragua. The distance within which the vessels of the two powers were to be exempt from blockade and capture, in case of war, was fixed at twenty-five nautical miles from each of the termini of the canal. Nicaragua, however, refused to accept the terms of the agreement.

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[1] Snow, *Treaties and Topics in American Diplomacy*, pp. 333, 334.

On July 17, 1852, the islands of Roatan, Bonacca, Utilla, Barbarat, Helene, and Morat were officially proclaimed a crown colony under the title of "The Colony of the Bay Islands." This was generally regarded in the United States as a flagrant violation of the Clayton-Bulwer treaty, and the matter was immediately taken up by Congress at its session of December, 1852. The Senate requested the President to lay before that body all information obtainable on that subject.[1] In the same session the Senate passed a resolution to the effect that the pretensions of Great Britain to the Mosquito Coast and the Bay Islands were violations of the Clayton-Bulwer treaty.

The chief point of dispute was the interpretation of the article relating to the occupation of Central America. Great Britain maintained that "the design of the contracting parties was not to disturb any state of things then existing;" the United States, on the contrary, insisted that the treaty was both prospective and retroactive in its operation.[2]

After the failure of Mr. Webster's efforts, the negotiations were transferred to London, and there continued by Mr. Buchanan and Mr. Dallas. The latter succeeded in concluding the Dallas-Clarendon treaty (October 17, 1856). The Dallas-Clarendon treaty failed of ratification in England because of an amendment added by the United States Senate by which Great Britain was to give up all rights to the Bay Islands, and to recognize them "as under the sovereignty and as part of the Republic of Honduras."

The British government immediately proposed another treaty in all respects identical with the Dallas-Clarendon treaty as amended by the Senate, but with a proviso to the effect that the recognition as to the position of the Bay Islands was to be conditioned upon the conclusion of a treaty between Great Britain and

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[1] This was done January 4, 1853, *Messages and Papers of the Presidents*, Vol. V. p. 183.

[2] Mr. Marcy to Mr. Dallas, May 24, 1856. Senate Executive Document No. 161, 56th Congress, 1st Session, p. 3.

Honduras. This proposal was rejected by the American government.[1] The Clayton-Bulwer treaty therefore remained the measure of the rights of the two governments in Central America. As to the disposition of the difficulties arising out of that treaty, President Buchanan suggested that "the wisest course would be to abrogate it by mutual consent and to restore the *status quo ante.*[2] The only other means of settlement was arbitration. This was suggested by Great Britain, but rejected by the United States.

Shortly thereafter the United States concluded with Nicaragua the Cass-Yrissari treaty (November 16, 1857). By the terms of this treaty the United States secured the right of transit across the territories of Nicaragua, and the right to use the canal on the same terms as Nicaragua. The latter agreed further to establish two free ports, one at each terminus of the canal, but reserved the rights of sovereignty over the channel. The United States agreed to extend their protection to the routes of communication, to guarantee the neutrality of the canal, and to invite other nations to join with them in such protection and guaranty of neutrality. This treaty was not acceptable to the British government, and was objected to as a violation of the Clayton-Bulwer treaty. No serious question, however, arose, as the Republic of Nicaragua refused to ratify the act of its negotiator, an action, in part at least, attributable to the filibustering expeditions of Walker.[3]

In the autumn of 1857, the British government sent a special commissioner, Sir William Ouseley, to Central America in order to settle by means of separate treaties with the Central American republics the controversies arising out of the Clayton-Bulwer treaty. The special objects of his mission were: (1) the cession of the Bay Islands to Honduras; (2) the substitution of the sovereignty of Nicaragua for the protectorate of England in Mosquitia; and (3) the regulation of the frontiers of Belize. When the purpose of the Ouseley mission was communicated to President Buchanan by Lord Napier the former intimated that such an arrangement would be acceptable to the United States, provided that the controversies be settled in substantial accordance with the American construction of the treaty.[1] Sir William Ouseley was succeeded by Charles Lennox Wyke, who concluded treaties with Guatemala (April 30, 1859) in reference to the boundaries of Belize, with Honduras (November 28, 1859) for the restoration of the Bay Islands, and with Nicaragua (January 28, 1860) concerning the Mosquito protectorate. Under the last treaty Great Britain recognized the sovereignty of Nicaragua over the Mosquito territory, and agreed that the protectorate cease three months after the ratification of the treaty.[2]

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[1] *Messages and Papers of the Presidents,* Vol. V, p. 444.

[2] *Ibid.*

[3] Travis, *The History of the Clayton-Bulwer Treaty,* pp. 183 *et seq.*

In August, 1860, copies of these treaties were officially communicated to the United States and the controversies with Great Britain seemed at an end. In his annual message to Congress President Buchanan says: "The discordant constructions of the Clayton-Bulwer treaty * * * have resulted in a final settlement entirely satisfactory to this government."[3]

Shortly after the riots on the isthmus of Panama in 1856, the United States attempted to negotiate a new treaty with Colombia by which the former power was to acquire by purchase all the rights of the latter in the Panama railroad, and to secure certain islands at the termini of the canal as naval stations. The offer was, however, declined by Colombia.

In May, 1858, Nicaragua forfeited the charter of the American Canal Company and transferred all the rights of that company to M. Felix Belly of Paris. In addition to this the French government was given the right to station two war ships at the termini of the canal or in Lake Nicaragua. Against this the American government immediately protested. The Nicaraguan government was informed that no concession should be made which would interfere with engagements previously made with citizens of the United States, nor would the American government admit of the provision allowing the French government to station warships in Lake Nicaragua.[4] The French government failed to support M.

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[1] Lord Napier to the Earl of Clarendon, October 22, 1857. Senate Executive Document No. 161, 56th Congress, 1st Session, pp. 114 *et seq.*

[2] On November 20, 1894, the Mosquito Reserve became a territory of Nicaragua.

[3] *Messages and Papers of the Presidents*, Vol. V, p. 639.

[4] Mr. Cass to Mr. Lamar, July 25, 1858. Senate Executive Document No. 161, 56th Congress, 1st Session, pp. 134, 135.

Belly, and in 1861 the American company re-organized and received its former concessions, thus closing an incident that might otherwise have led to serious complications. "It is a source of much satisfaction," says President Lincoln, in his annual message of 1864, "that the difficulties which for a moment excited some political apprehensions and caused a closing of the interoceanic transit route have been amicably adjusted."[1]

We may conclude that at the outbreak of the civil war all the questions relating to the trans-isthmian canal were satisfactorily adjusted. During the first half of the 60's domestic affairs absorbed the attention of the American people. But no sooner was peace restored than public interest in the isthmian transit revived. The assured success of the Suez enterprise again turned the attention of statesmen and capitalists to the Central American undertaking.

The close of the war marks the beginning of a new line of policy in regard to the canal. Prior to this we have seen that in every negotiation authorized by the government the United States sought no exclusive privileges in the transit routes, but desired merely their absolute neutrality. To attain this the United States had even departed from the Monroe doctrine, and had entered into an "entangling alliance" with Great Britain in concluding the Clayton-Bulwer treaty. But the outcome of the trial at arms produced self-reliance, and this in turn gave birth to a broader and more aggressive foreign policy. The statesmen of the succeeding period, we shall see, almost without exception, demanded that the United States have the control over whatever canal route be opened across the isthmus.

The old view is, however, still reflected in the Dickinson-Ayon treaty with Nicaragua (June 21, 1867). By this treaty the United States obtained the right of transit across the territory of Nicaragua and the right of transporting troops and munitions of war across such territory, provided the same were not to be employed against any Central American state friendly to Nicaragua. Nicaragua agreed to establish a free port at each terminus of the canal. The United States in turn agreed to extend their protection to the routes of communication, to guarantee the neutrality and innocent use of the same, and to induce other nations to join them in such guaranty of protection and neutrality.

[1] *Messages and Papers of the Presidents*, Vol. VI, p. 243.

President Grant took a personal interest in the canal, and favored its construction as a government enterprise. General Stephen A. Hurlbut was sent to Colombia, and there concluded the treaty of Bogota, January 26, 1870. Before, however, considering the terms of this convention, we must review briefly the efforts of the preceding administration. Negotiations had been begun by Mr. Seward in 1868 which resulted in the conclusion of a treaty with Colombia on January 14, 1869. According to this treaty, the obligations of which were to be permanent, the United States obtained the sole right to construct the canal, and to control the same, if necessary, by military force, and were guaranteed the peaceable enjoyment, control, and management thereof. Colombia was to retain the political sovereignty and jurisdiction over the channel. This treaty was submitted to the Senate on February 15, 1869, but failed of ratification. The treaty concluded by Mr. Hurlbut provided for an international guaranty of neutrality by allowing other nations to enter into similar stipulations. Both of the contracting parties reserved the right of passage for their own war vessels, but provided that the ships of war of nations at war with either of them were to be excluded. The United States guaranteed that the canal was to be exempt from all hostile acts. To this treaty the Parliament of Colombia made a number of amendments which the United States Senate refused to accept.

The International Scientific Congress convened in Paris in 1879. The United States were represented by eleven delegates who were, however, instructed not to commit their government to any plan or policy. The adoption of the Panama route—by what means need not be here related—again centered public attention on the lower isthmus. The United States could not but regard the French enterprise with jealousy, and as a violation of the Monroe doctrine. It was believed that M. de Lesseps desired a joint protectorate of the canal by the European powers. The subject was extensively discussed at the meeting of Congress of that year, and the Clayton-Bulwer treaty came in for its share of attention. The Senate passed a resolution that no canal should be allowed to be opened unless it was practically under the control of the United States. On April 16, 1880, the Senate passed a resolution to abrogate the Clayton-Bulwer treaty.

On March 8, 1880, President Hayes announced in unequivocal language the policy of his administration on the subject of the isthmian transit: "The policy of this country is a canal under American control. The United States can not consent to the surrender of this control to any European power, or to any combination of European powers. If existing treaties between the United States and other nations, or if the rights of sovereignty or property of other nations stand in the way of this policy—a contingency which is not apprehended—suitable steps should be taken by just and liberal negotiations to promote and establish the American policy on this subject consistently with the rights of the nations to be affected by it. * * * An interoceanic canal across the American isthmus will essentially change the geographical relations between the Atlantic and Pacific coasts of the United States and between the United States and the rest of the world. It would be the great ocean thoroughfare between our Atlantic and our Pacific shores, and virtually a part of the coast line of the United States. Our merely commercial interest in it is greater than that of all other countries, while its relations to our power and prosperity as a nation, to our means of defense, our unity, peace, and safety, are matters of paramount concern to the people of the United States. No other great power would, under similar circumstances, fail to assert a rightful control over a work so closely and vitally affecting its interest and welfare. * * * It is the right and the duty of the United States to assert and maintain such supervision and authority over any interoceanic canal across the isthmus that connect North and South America as will protect our national interests."[1]

In accordance with this line of policy, Mr. Evarts proposed a treaty with Colombia by which "all concessions and privileges granted or to be granted by the United States of Colombia with the view of assuring the construction of an interoceanic canal * * * are and shall be subject to the rights acquired by the United States of America by virtue of the guaranty given by them in the thirty-fifth article of the treaty of 1846." Colombia was to obtain the consent of the United States before granting any concessions, and to permit the latter power to fortify the canal. This proposal was rejected, and a modified treaty concluded February 17, 1881, failed of ratification by Colombia.[1]

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[1] *Messages and Papers of the Presidents*, Vol. VII, pp. 585, 586.

President Garfield accepted the views of his predecessors. "We will urge no narrow policy," says he in his inaugural address, "nor seek peculiar or exclusive privileges in any commercial route; but * * * I believe it to be the right and duty of the United States to assert and maintain such supervision over any interoceanic canal across the isthmus that connects North and South America as will protect our national interests."[2]

The report was current that the European powers were endeavoring to effect a joint guaranty of the de Lesseps enterprise. It was as a protest to such action that Mr. Blaine sent a circular letter of instructions to the American ministers at the European courts. Mr. Blaine disclaimed any intention on the part of the United States to interfere in the management of the canal viewed purely as a commercial enterprise, nor in its use in times of peace. "But," continues Mr. Blaine, "it is, as regards the political control of such a canal, as distinguished from its merely administrative or commercial regulation, that the President feels called upon to speak with directness and emphasis. During any war to which the United States of America * * * might be a party, the passage of armed vessels of a hostile nation through the canal of Panama would be no more admissible than would the passage of armed forces of a hostile nation over the railway lines joining the Atlantic and Pacific shores of the United States. * * * The United States will insist upon her right to take all needful precautions against the possibility of the isthmus transit being in any event used offensively against her interests upon the land or upon the sea. * * * An agreement between the European states to jointly guarantee the neutrality and in effect control the political character of a highway of commerce, remote from them and near to us, forming substantially a part of our coast line, and promising to become the chief means of transportation between our Atlantic and Pacific states, would be viewed by this government with gravest concern."[3]

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[1] Snow, *Treaties and Topics in American Diplomacy*, pp. 340, 341.

[2] *Messages and Papers of the Presidents*, Vol. VIII, p. 11.

[3] Mr. Blaine to Mr. Lowell (and *mutatis mutandis* to the other American representatives), June 24, 1881. Senate Executive Document No. 161, 56th Congress, 1st Session, pp. 174-176.

It is worthy of note that Secretary Blaine ignored entirely the existence of the Clayton-Bulwer treaty. Lord Granville's reply was merely to the effect that, so far as Great Britain was concerned, all rights were determined by the Clayton-Bulwer treaty and that "Her Majesty's government rely with confidence upon the observance of all the engagements of that treaty."[1]

Prior to the receipt of Lord Granville's communication, Mr. Blaine had dispatched his famous letter of November 19, 1881, which has been rightly called "one of the most remarkable state papers ever penned." In July of this year the award of the Emperor of Austria in the disputes between Great Britain and Nicaragua arising out of the treaty of Managua (January 28, 1860) had been made public, and under that award Great Britain had revived the old protectorate over the Mosquito territory.

Mr. Blaine insisted that the Clayton-Bulwer treaty was no longer binding on the United States because it was concluded over thirty years ago, under exceptional and extraordinary circumstances. That since the conclusion of the treaty the remarkable development of the Pacific coast had devolved new responsibilities on the American government which made some changes in the Clayton-Bulwer treaty imperative. The mutual promises of the two governments not to fortify the canal placed the United States at a decided disadvantage by reason of the superior naval strength of England. Nor would a guaranty of neutrality by all the European powers prove any more effectual because "the first sound of a cannon in a general European war would in all probability annul the treaty of neutrality, and the strategic position of the canal, commanding both oceans might be held by the first naval power that could seize it. * * * It consequently becomes evident that the one conclusive mode of preserving the isthmus canal from the possible distraction and destruction of war is to place it under the control of that government least likely to be engaged in war (scil. the United States)." On these grounds the American secretary of state proposed, as one of the required modifications of the treaty, that permission be granted to the United States to fortify the canal and to obtain the political control of it in conjunction with the nation through whose territory it was to pass.[1]

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[1] Lord Granville to Mr. Hoppin, Nov. 10, 1881. Senate Executive Document No. 161, 56th Congress, 1st Session, p. 178.

To this Lord Granville replied that the development of the Pacific coast had not been an unexpected one, and that it was certainly not such a change of conditions as to warrant "vitiating the foundations of an agreement which can not be supposed to have been concluded without careful thought and deliberation." Lord Granville then pointed out that the interests of Great Britain in the canal are equal to those of the United States.

Upon the retirement of Mr. Blaine, the discussion was taken up by Mr. Frelinghuysen. The new secretary of state maintained that the Clayton-Bulwer treaty was voidable at the option of the United States on two grounds: First, that the treaty had in view a particular object, to wit, a then projected canal by the Nicaragua route. The main reason for the admission of Great Britain on equal terms with the United States was that the necessary capital required for the construction could not be obtained in this country. That on the failure of that particular project the reason for the continued enforcement of the treaty ceased.[2] Second, that Great Britain had violated a material provision of that treaty by erecting the "settlement" of Belize into a crown colony, contrary to the stipulation of the contracting parties that neither shall colonize Central America.

In reply to Lord Granville's argument that the eighth article negatived the intention of the parties to apply the provisions of the treaty only to a then projected canal, Mr. Frelinghuysen states that Article VIII. in terms related only to the protection of the communication *now* (i. e., 1850) proposed to be established by the way of Tehuantepec or Panama. That, moreover, the article was merely a declaration of intention to enter into negotiations at some subsequent time upon the subjects there specified.[3]

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[1] Mr. Blaine to Mr. Lowell, November 19, 1881. Wharton, *Digest of the International Law of the United States*, Vol. II, pp. 209-215.

[2] Of this argument Mr. Olney, secretary of state under President Cleveland, says: It "is ingenious rather than sound, antagonizes the language of the treaty itself, and is unsupported by any contemporary conduct or construction." *The Clayton-Bulwer Treaty*, p. 15.

[3] Letters of Mr. Frelinghuysen to Mr. Lowell, May 8, 1882, May 5, 1883, and November 22, 1883. Wharton, *Digest of the International Law of the*

President Arthur favored a canal by way of Lake Nicaragua. He believed that French influence would continue to dominate the lower isthmus, and that this should be counter-balanced, if need be, by the construction of a second canal by way of Nicaragua. Negotiations were entered into with Nicaragua and resulted in the Frelinghuysen-Zavala treaty of December 1, 1884. The first article of the treaty provides that "the canal shall be built by the United States of America, and owned by them and the Republic of Nicaragua." The next article stipulates that "there shall be perpetual alliance between the United States and the Republic of Nicaragua; and the former agree to protect the integrity of the territory of the latter."

The Frelinghuysen-Zavala treaty was withdrawn from the Senate by President Cleveland, who entirely repudiated the policy of his immediate predecessors in regard to the canal. "The lapse of years," says the President, "has abundantly confirmed the wisdom and foresight of those earlier administrations which long before the conditions of maritime intercourse were changed and enlarged by the progress of the age, proclaimed the vital need of interoceanic transit across the American isthmus, and consecrated it in advance to the common use of mankind. * * * Toward such realization the efforts of my administration will be applied, ever bearing in mind the principles on which it must rest, and which were declared in no uncertain terms by Mr. Cass, who, while secretary of state, in 1858, announced that 'what the United States want in Central America, next to the happiness of its peoples, is the security and neutrality of the interoceanic routes which lead through it.' "[1]

The American company organized shortly after the conclusion of the Frelinghuysen-Zavala treaty obtained a concession from the Nicaraguan government to build and operate a canal for the period of ninety-nine years. An accessory construction company was also organized, and work was seriously undertaken on the channel.

President Harrison, in his second annual message to Congress, recommended that the United States guarantee the bonds of the

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United States, Vol. II, pp. 219-235. For a criticism of the positions taken by Mr. Freylinghuysen, *vide* Lawrence, *Essays on Some Disputed Questions in International Law*, p. 121 *et passim.*

[1] *Messages and Papers of the Presidents*, Vol. VIII, p. 328.

canal company in order to prevent their sale at a large discount. The United States were, in case of loss, to be subrogated to the rights of first mortgagees, and to retain a control of the stock of the enterprise.[1] Mr. Harrison had also supported the Frelinghuysen-Zavala treaty while he was in the Senate.

The annexation of Hawaii and the events of the Spanish-American war, notably the long voyage of the "Oregon" around Cape Horn, again demonstrated the urgent need of the canal, and the necessity of its control by this government. Accordingly we find a recommendation to that effect in the second annual message of President McKinley in the following terms: "That the construction of such a maritime highway is now more than ever indispensable to that intimate and ready intercommunication between our eastern and western seaboards demanded by the annexation of the Hawaiian Islands and the prospective expansion of our influence and commerce in the Pacific, and that our national policy now more imperatively than ever calls for its control by this government, are propositions which I doubt not the Congress will duly appreciate and wisely act upon."[2]

On February 5, 1900, secretary of state Hay and the British representative, Lord Pauncefote, concluded a treaty by which the rights of their respective governments were determined anew. By this treaty the United States were empowered to construct the canal, or to permit its construction by individuals, and to make rules for its regulation and management. (Art. I.) As a basis for the neutralization of the canal, "the high contracting parties" adopted the rules of the treaty of Constantinople of October 29, 1888. (Art. II.) Both parties agreed to invite other nations to join them in the guaranty of neutrality. (Art. III.)

The Senate adjourned in June, 1900, without ratifying the treaty, and Great Britain extended the period of ratification to March 4, 1901. At the opening of the session of Congress in the following December, the canal treaty formed the chief topic of discussion. On December 13, the Senate adopted the "Davis amendment" by which the first five sections of Article II. were declared not to apply "to measures which the United States may

[1] *Ibid.*, Vol. IX, pp. 188-190, 317.

[2] *Ibid.*, Vol. X, p. 180.

find it necessary to take for securing by its own forces the defense of the United States and the maintenance of public order." Two days thereafter Senator Foraker proposed the insertion of the words "which convention is hereby superseded" after the words "Clayton-Bulwer treaty" in the first article, and further the entire omission of the third article. Both of these amendments were adopted, and the treaty in its amended form was ratified on December 20, 1900.

The amendments did not prove acceptable to the British government, and on November 18, 1901, a new treaty was concluded by the negotiators of the first treaty. Under the new Hay-Pauncefote treaty, which was ratified by the Senate on December 16, 1901, the Clayton-Bulwer treaty is declared to be superseded (Art. I.), and the United States are given the same rights as to the construction of the canal as under the first treaty. (Art. II.) The third article provides that the "United States adopts" as a basis of neutralization the rules of the Suez canal convention. The new treaty omits the prohibition against the erection of fortifications along the canal, but the United States is given the right to police the canal, as under the old treaty. It furthermore substitutes for the provision in the 1900 treaty by which the canal was to remain free and open "in time of war as in time of peace to the vessels of commerce and of war of all nations," a stipulation that the canal shall "be free and open to the vessels of commerce and war of all nations observing these rules," without the addition of the words "in time of war as in time of peace." The "Davis amendment" was not embodied in the new treaty. Nothing is said concerning the accession of other powers to the treaty, but the fourth article stipulates that "no change of territorial sovereignty or of the international relations of the country or countries traversed by the before-mentioned canal shall affect the general principle of neutralization or the obligation of the high contracting parties."

Before discussing the most recent events on the isthmus, we shall review briefly the attitude of the legislative branch of the government towards the undertaking. In 1889, the Senate, by an almost unanimous vote, passed a resolution to the effect that any connection with a European power in regard to the trans-isthmian canal would meet with its disapproval. On January 10, 1891, the

Senate Committee on Foreign Relations presented a bill under which the government was to guarantee an issue of bonds of the Nicaragua Canal Company to an amount not exceeding $100,000,000, in return for which the government was to receive $70,000,000 of stock. In December of the following year, a similar bill was introduced, by which the United States was to receive $80,500,000 of stock. To this Senator Quay proposed an amendment that the United States first secure the right to fortify the termini of the canal, and to maintain one or more vessels of war on Lake Nicaragua; and Senator Stewart submitted an amendment that the United States purchase the rights of the canal company and build the canal as a government enterprise.

On August 15, 1893, Senator Frye introduced a bill by which the United States were to guarantee an issue of bonds amounting to $100,000,000, in consideration of receiving all the stock of the company remaining after the payment of $12,000,000 to the Canal Company, and any further sum still due Nicaragua and Costa Rica for the concessions granted. On January 22, 1894, Senator Walthall, in behalf of Senator Morgan, introduced a bill by the terms of which the government was to guarantee $70,000,000 of bonds of the company and receive in return $70,000,000 in stock. An amendment was again proposed by Senator Quay similar in terms to that proposed by him in the preceding session.

In the following year the House Committee on Interstate and Foreign Commerce reported a bill by which the stockholders in the Canal Company were to receive in exchange for their old stock an amount sufficient to reimburse them for actual expenditures, the government practically controlling the undertaking. This bill was discussed for almost a month in 1897.

On June 1, 1896, Senator Morgan introduced another bill, similar to the one submitted in January, 1891, and noted above. To this Senator Rawlins submitted an amendment that the act should not take effect until the United States secured the right to fortify the canal, and that the right to move troops and munitions of war across the canal in times of war, should be open only to the United States, Costa Rica, and Nicaragua.

On December 15, 1898, Senator Caffery moved as a substitute another bill providing for the payment of $5,000,000 to the Canal Company, and the building of the canal as a government undertaking at a cost not exceeding $140,000,000.

Senator Spooner submitted an amendment by which the President, if unable to secure such concession from Nicaragua and Costa Rica as will enable the government to own and control the canal, was authorized to negotiate for the ownership and control of some other canal; and that the President be further authorized to negotiate for the abrogation or modification of any treaties which might interfere with such ownership and perpetual control by the United States. The bill, in substantially its original form, was passed in the Senate by a vote of 48 to 6. The House, however, refused to concur.

The Maritime Canal Company's franchises were formally declared forfeited for non-compliance with the conditions annexed, in 1898. In October of the same year, a new Canal Company was organized, and both organizations appealed to Congress and the Executive for recognition and assistance. About the same time the Panama Company began its efforts to interest the United States government in its behalf.

On December 7, 1899, a bill "to provide for the construction of a canal connecting the waters of the Atlantic and Pacific oceans" was introduced in the House by Mr. Hepburn. The House bill as originally introduced provided for the acquisition of such of the territory of Costa Rica and Nicaragua as might be necessary to excavate, construct, and defend a canal to extend from a point near Greytown (San Juan) via Lake Nicaragua to Brito. The bill as finally passed, May 2, 1900, by a vote of 224 to 36, provided in general terms for the acquisition of such territory as may be desirable and necessary for the excavation, construction and preservation of a canal extending from some point on the Carribean Sea to some point on the Pacific Ocean, the route selected to be such as the President shall determine. The bill further provided for an ultimate appropriation of $140,000,000.

A similar bill introduced in the Senate on December 18, 1899, appropriating $130,000,000 and providing for a modification of the Clayton-Bulwer treaty, failed of acceptance by a vote of 15 to 33 (April 14, 1900).

On December 4, 1901, a bill "to provide for acquiring the right necessary for the construction of a canal connecting the waters of the Atlantic and Pacific oceans" was introduced by Senator Morgan.

The act finally passed, and approved June 28, 1902, provides for the acquisition by the government of the United States of all the rights, property, and franchises of the New Panama Canal Company at a cost not exceeding $40,000,000. The President is further authorized to acquire from the Republic of Colombia the perpetual control over a strip of land not less than six miles in width along the route of the Panama canal, and the right to exercise jurisdiction over said strip and the ports at the ends thereof. Should the President be unable to obtain on reasonable terms and within a reasonable time the rights and property of the Panama Company, and the control over the strip of territory from Colombia, he is authorized to negotiate with Costa Rica and Nicaragua for the acquisition of perpetual control of the territory necessary for the construction, maintenance, and protection of a canal by the Nicaragua route. Additional appropriations of not more than $135,000,000, or of not more than $180,000,000, according as the route selected be the Panama or the Nicaragua route, were made for the actual expenses of construction.

In accordance with the terms of this act negotiations were entered into with the Panama Company, and the sum of $40,000, 000 agreed upon as the compensation for all of the franchises, concessions, unfinished works, plants, and other property of the company. The Attorney-General, after an exhaustive investigation, concluded that the United States could acquire these rights by purchase from the existing company.

After considerable delay, due partly to the unsettled political situation in Colombia, partly to the personal attitude of the Colombian minister toward the entire negotiation, a treaty was finally concluded on January 22, 1903, by Secretary Hay and the Colombian chargé d'affaires, Dr. Herran. Under this agreement the United States were to receive substantially all of the rights which the President was authorized to negotiate for under the act of June 28, 1902. Two points were, however, conceded to Colombia: first, in order to avoid objections on constitutional grounds on the part of Colombia, the exclusive rights, instead of being granted in perpetuity, were granted "for the term of one hundred years, renewable at the sole and absolute option of the United States, for periods of similar duration so long as the United States may desire;" second, it was stipulated that "the rights and privileges granted to the United States * * * shall not affect the sovereignty of the Republic of Colombia over the territory within whose boundaries such rights and privileges are to be exercised. The United States freely acknowledges and recognizes this sovereignty, and disavows any intention to impair it in any way whatever, or to increase its territory at the expense of Colombia or any of the sister republics in Central or South America, but, on the contrary, it desires to strengthen the power of the republics on this continent, and to promote, develop, and maintain their prosperity and independence."

The Hay-Herran treaty was ratified by the United States Senate on March 17, and laid before the Colombian Congress early in the following July. For reasons that will perhaps never be fully known, the Colombian Senate rejected the treaty by an almost unanimous vote, and adjourned after approving a bill authorizing the government to enter into new negotiations providing for an increase in the cash payment and annuities, and the retention of jurisdiction of Colombia over the canal zone.

After the rejection of the Hay-Herran treaty, events followed each other with astounding rapidity. On November 3, the expected revolution in Panama began. Colombia, entirely unprepared, offered no resistance. On the 6th the United States recognized the de facto government in Panama in the following telegram to Mr. Ehrman: "The people of Panama have, by unanimous movement, dissolved their political connection with the Republic of Colombia and resumed their independence. When you are satisfied that a de facto government, republican in form and without substantial opposition from its own people, has been established in the state of Panama, you will enter into relations with it as the responsible government of the territory and look to it for all due action to protect the persons and property of citizens of the United States, and to keep open the isthmian transit in accordance with the obligations of existing treaties governing the relations of the United States to that territory." At the same time the American representative at Bogota was instructed to communicate to the Colombian government the action taken by the United States, and to recommend the peaceful and equitable settlement of all questions that might arise between Colombia and her revolted state.

On the following day M. Philippe Bunau-Varilla was appointed the diplomatic representative of the new republic at Washington, and was officially received as such by the President on the 13th. Three days later the correspondence and documents relating to the affairs in Panama were made public.

President Roosevelt, in his annual message of December 7, 1903, as well as in a special message transmitted on January 4th of the present year, sets forth the facts justifying the action of the United States. In the first message, after detailing the acts of the United States on the isthmus, he states that they establish beyond question: "first, that the United States has for over half a century patiently and in good faith carried out its obligations under the treaty of 1846; second, that when for the first time it became possible for Colombia to do anything in requital of the services thus repeatedly rendered to it for fifty-seven years by the United States, the Colombian government peremptorily and offensively refused thus to do its part, even though to do so would have been to its advantage and immeasurably to the advantage to the state of Panama, at that time under its jurisdiction; third, that throughout this period revolutions, riots, and factional disturbances of every kind have occurred one after the other, in almost uninterrupted succession, some of them lasting for months or even for years, while the central government was unable to put them down or to make peace with the rebels; fourth, that these disturbances, instead of showing any sign of abating, have tended to grow more numerous and more serious in the immediate past; fifth, that the control of Colombia over the isthmus of Panama could not be maintained without the armed intervention and assistance of the United States. * * * Under such circumstances the government of the United States would have been guilty of folly and weakness amounting in their sum to a crime against the nation had it acted otherwise than it did when the revolution of November 3 last took place in Panama. This great enterprise of building the interoceanic canal can not be held up to gratify the whims, or out of respect to the governmental impotence, or to the even more sinister and evil political peculiarities, of people who, though they dwell afar off, yet against the wish of the actual dwellers on the isthmus assert an unreal supremacy over the territory. The possession of a territory fraught with such peculiar capacities as the isthmus in question carries with it obligations to mankind. The course of events has shown that this canal can not be built by private enterprise or by any other nation than our own; therefore, it must be built by the United States." In his special message the President states that the recognition of Panama can be justified on three grounds: first, the treaty rights of the United States; second, the national interests of commercial development and self-defense; and third, the interests of collective civilization in the maintenance of an open highway across the isthmus.

In reference to the insinuations that have been made in various quarters to the effect that the government of the United States was implicated in the revolutionary movement in Panama, President Roosevelt states that they are "as destitute of foundation as of propriety. * * * No one connected with this government had any part in preparing, inciting, or encouraging the late revolution."

The negotiations entered into between Mr. Hay and M. Bunau-Varilla resulted in the conclusion of a treaty (November 18th) which was submitted to the Senate at the opening of the present session. By the terms of this agreement "the Republic of Panama grants to the United States in perpetuity the use, occupation, and control of the zone of land and land under water for the construction, maintenance, operation, sanitation, and protection of said canal of the width of ten miles, extending to the distance of five miles on each side of the center line of the route of the canal to be constructed; the said zone beginning in the Caribbean Sea, three marine miles from mean low-water mark, and extending to and across the isthmus of Panama into the Pacific Ocean to a distance of three marine miles from mean low-water mark, with the proviso that the cities of Panama and Colon and the harbors adjacent to said cities, which are included within the boundaries of the zone above described, shall not be included in this grant. The Republic of Panama further grants to the United States in perpetuity the use, occupation, and control of any other lands and waters outside of the zone above described which may be necessary and convenient for the construction, maintenance, operation, sanitation, and protection of the said canal or of any auxiliary canals or other works necessary and convenient for the construction, maintenance, operation, sanitation, and protection of the said enterprise. The Republic of Panama further grants to the United States in perpetuity the use, occupation, and control of all islands within the limits of the zone above described, and in addition thereto the group of small islands in the Bay of Panama named Perico, Nacs, Culebra, and Flamingo." (Art. II.) The sovereignty and jurisdiction of the United States within these limits is to be absolute. (Art. III.) The United States further receive in perpetuity the monopoly of all systems of canal or railroad transportation across the isthmus. (Art. IV.) Colon and Panama, and the termini of the canal are declared free ports (Art. IX.), and the two first-named are subjected to the sanitary regulations made for them by the United States. (Art. VII.) The United States are given the right to land and station troops, and to erect fortifications, in order to protect the canal. (Art. XXI.) Finally, no change in the government or laws of Panama affecting the rights of the United States can be made without the consent of the latter power. (Art. XXIII.)

In return, the United States guarantees to Panama its independence, and is to pay the latter power the sum of $10,000,000 upon the exchange of ratifications, and beginning nine years from that date, the sum of $250,000 annually during the continuance of the agreement. (Art. XXII.) The canal, when constructed, and the entrances thereto shall be neutral in perpetuity. (Art. XVI.)

This treaty was ratified by the provisional government of Panama, without amendment, on December 2d. Ratification by the United States Senate was delayed by the obstructive tactics of the Democratic minority, who seized the opportunity for arraigning the President's entire policy in reference to the recognition of Panama, and the negotiation of the treaty. An effort to bind the Democrats by caucus rule, however, failed. February 23d was finally agreed upon for the taking of the vote, and upon this day the treaty was ratified, without amendment, by a vote of 66 to 14. All of the Republican and fourteen of the Democratic Senators voted in favor of the measure. An amendment to grant compensation to Colombia for the loss of Panama was rejected by a vote of 24 to 49. The ratifications were exchanged at Washington on February 26th.

In following the history of the negotiations in reference to the trans-isthmian canal it will have become apparent that the United States has followed three distinct lines of policy. The first, which distinguished the diplomacy prior to the civil war, favored the construction of the canal as a private enterprise, and its free and unlimited use by all nations, subject to control by none. The second line of policy was inaugurated as part of the larger diplomacy of Mr. Seward, and was carried to its height by Mr. Blaine and Mr. Frelinghuysen. This policy still advocated a canal constructed by private capitalists, but subject to the political control of the United States. The third and present policy is that of a canal constructed as a government enterprise, and under the control of the United States. This view was clearly favored by President Grant, but did not become a settled policy of the government until the administrations of Harrison and McKinley. It finds its latest and most effective expression in the act of Congress of June 28, 1902, and in the Panama treaty.

The canal is assured, and events have decided the question of the route. After centuries the strait will be made to yield up its secret. It is submitted that, for the present, government control of the canal by the United States furnishes the best possible solution of its international position. Time alone will show whether Europe will acquiesce in America's exclusive control over a great highway of commerce.

From the view-point of world politics the construction and operation of the canal as a government undertaking means the extension of the political control of the United States over the Spanish-American nations. Perhaps the canal may one day become "a part of the coast line of the United States." The next generation may see the fulfilment of the prophecy of de Tocqueville that the Anglo-American empire will some day extend from the polar ice to the tropics.

THE COMMERCIAL CLUB
CHICAGO

THE ISTHMIAN CANAL

AN ADDRESS BY
MR. GEORGE S. MORISON
OF NEW YORK

DELIVERED
JANUARY TWENTY-FIFTH
1902

THE ISTHMIAN CANAL.

AN ADDRESS BY
MR. GEORGE S. MORISON
BEFORE
THE COMMERCIAL CLUB OF CHICAGO
JANUARY 25, 1902

Mr. President and Gentlemen of the Commercial Club :

History has been making itself so fast in the last two or three weeks that I had somewhat changed my ideas as to what I had better say. I had determined to devote nearly my whole time to a description of the actual conditions on the Isthmus, and to giving reasons why the commission had reached some of the conclusions which it has. The remarks just made by my friend Ripley seem to make it important that I should first say a word or two in a different direction.

The first thing that I will call your attention to is the fact that although the old canals in America have almost all passed out of use, there has never been a time when canal construction has been more active in Europe than it is to-day, and there has never been a time when it has been considered as important a part of the transportation system of European countries. I do not know what the statistics are, but we all know that Paris is practically an inland city; it is a long way from the sea, and yet I feel perfectly certain that a good deal more than half the food and other supplies that are consumed in Paris are practically brought in by canal, either by local canals, of which France has a very extensive system, or by boats of the canal class on the Seine. This is a fact which should not be forgotten.

But the principal feature of the Isthmian canal, I think, may be said to be that it is not a canal in the usual sense. It is built, not to make canal navigation, not to increase navigation, but to reduce navigation. It is the formation of a short strait connecting two oceans. We have in this neighborhood another instance precisely like it, of a short canal connecting two seas, Lake Superior and Lake Huron, which now carries the heaviest tonnage that any canal ever has carried in the world ; and it carries it, not because it is a canal, but in spite of its being a canal. It carries it because it is the only way of getting from one lake to the other.

If you will study the geography of the world, you will see that there is a very marked difference in the formation of the two continents. The Eastern Continent is broad from east to west; the Western Continent is long from north to south. The Eastern Continent has been completely circumnavigated. The passage around the Cape of Good Hope is a very easy passage, frequently made. The Western Continent has never been circumnavigated, and although the dream of a northeast passage has been a most enticing thing for centuries, it has had to be given up. Cape Horn is practically 20 degrees farther south than the Cape of Good Hope. Its passage is a very difficult one, especially in the winter season. The attraction of the Isthmian canal is that it will avoid the necessity of circumnavigating this continent. In spite of its being a canal it will make ocean navigation a great deal easier than it is now. The Suez canal has done this for the other continent, where the difficulties of getting around the continent were very much less. It remains to be seen what a canal across the American Isthmus will do. But its position and its importance is not because it is a canal, but in spite of its being a canal; a strait 20 miles wide would be a great deal better, but we cannot make it.

This subject of Isthmian transit is as old as any knowledge of the continent. The first dream of Columbus was to get a westward course to the Orient. He thought he had done it. He had not. The next dream actually accomplished it. Magellan found the straits, and on the boldest voyage that any navigator ever made, he crossed the Pacific Ocean, not knowing that only a short distance beyond these straits was the end of the land, which he might have gone around.

Of late years three different conditions of things have called special attention to Isthmian transit. The first of these was the discovery of gold in California; that was a little more than fifty years ago. It was at that time that the first surveys of any importance were made for lines across the Isthmus. The second was the Suez canal; when that was built, and was a success, its promoters felt that they wanted to do the same thing again; that it must be done by some one, and they would do it themselves; they tried and they failed. They failed for other reasons than those for which they should have failed, but it was a failure; that was about 20 years ago. The next thing which called attention to it was the voyage of the Oregon, one of the most graphic events in the war with Spain; the voyage of the Oregon was made through the straits of Magellan; it called everybody's attention to the fact that we could not get through the Isthmus.

In these three different periods a great change has taken place in the merchant marine. At the time the first surveys were made for the Nicaragua canal, the first that were good for anything, by Col. Childs, about fifty years ago, there were only about 260 steam vessels in the world, of which only fifteen drew more than 17 feet; that was the size of ship which he made his plans for. At the time that work on the Panama canal was begun in 1882, a bottom width of about 70 feet and a depth of 29½ feet, those being the dimensions which had been adopted then on the Suez canal, though larger than the original dimensions, were considered ample. The bottom width of the canal was less than the beam of some warships which are now building. One steamship company alone in nine months sent out from New York City forty ships drawing over thirty feet.

We are particularly familiar here with the great change which has taken place in railroad rolling stock, and the enormous difference in trainloads. The present economical railroad transportation is due to heavy locomotives, to heavy rails which carry them, and to cars which can carry heavy loads themselves. Instead of cars carrying ten tons, as we had thirty years ago, we have plenty of cars carrying fifty tons, and they are sometimes loaded to sixty. The same thing has taken place on the ocean. There are fleets of steamers crossing the Atlantic which carry 12,000 tons of cargo. There is at least one ship running to New York, and there are others building, which, when fully loaded, would carry 20,000 tons of cargo. There is a matter which leads to a great deal of confusion in regard to the size of both ordinary merchant ships and battle ships. There are four different methods of measuring a ship. There is the actual displacement, which is the way naval ships are measured; there is the gross tonnage, which is an arbitrary rule established by law; there is the net tonnage, which is a reduction from the gross tonnage by an arbitrary rule established by law, and there is the carrying capacity; all four are different. There are several merchant ships now on the ocean whose actual displacement if fully loaded would be between 30,000 and 40,000 tons. I have not seen the displacement scale of the Celtic, but it must be close to 40,000 tons. The Oceanic runs up to nearly 32,000 tons when fully loaded.

It is these conditions, these increased dimensions, which have rendered ocean transportation as economical as it is. We have seen the same thing in this country. We have had railroads reducing their cost of transportation, we have had ocean steamers reducing their cost, and lake steamers have reduced it; the one trouble has been on the Mississippi River and its tributaries, which have not been able to reduce it; and what has been the result? The railroads have taken all the transportation away from the rivers except that class which can be carried without power, cargoes of coal and grain which can be taken down the Mississippi River because the current of the Mississippi River takes them down ; but no considerable amount of freight can be brought back.

I have spent more time on this point than I had intended to ; but I wanted to speak of it particularly, because the route across the Isthmus which was best adapted to the light transportation of the past may be very poorly adapted to the transportation of the future.

The Nicaragua route has been favored, especially in America, for a great many years. Lake Nicaragua itself is but 12 miles from the Pacific, and the Continental Divide is between the lake and the Pacific. The drainage of the lake is into the Atlantic, Near the western end of Lake Nicaragua is the old City of Granada. In early times ships used to sail from Spain to Granada. They passed up the San Juan River, landed their cargoes at Granada, took their return cargoes and went back. I do not know how big those ships were, but they probably were about the same dimensions as the caravels which we saw here at the World's Fair a few years ago.

The transit company which operated a line from New York to San Francisco by way of Lake Nicaragua had steamers of about the size that then crossed the Atlantic. They would sail from New York, anchor in Greytown harbor, which was then a good harbor, although it has now disappeared, would transfer the passengers to river boats that came alongside. The river boat would go up the San Juan river to Castillo, where its passengers would get out and walk about a quarter of a mile around some rapids, take another boat which took them to the lake and across the lake and landed them within 12 miles of the Pacific, where a good stage road would take them in two hours to San Juan del Sur, where a steamer would be waiting for them. It seemed as if the San Juan river and Lake Nicaragua were an extension of the Atlantic Ocean, and that all that had to be done was to build a short canal between the lake and the Pacific and to improve the navigation of the river. The passage across this Divide was exceptionally easy. The stage road took the shortest route. The canal line would be about five miles longer, but the summit was but fifty feet above the lake, and everything was favorable to the construction of a canal. The one thing which was not seen at first, and which meant a great deal, but which means a great deal more now than it did then, was the fact that the San Juan River was but 100 miles long, and 100 feet higher at one end than at the other. It is a big river ; it is as big as the Mississippi is at Dubuque. It looks like a river which could easily be improved. But no river can have a fall of one foot to the mile without having very serious obstructions in it to navigation. In the upper half of the river those obstructions are rocks ; in the lower half they are sand bars. The first plan, that of Col. Childs' which was carefully worked out, contemplated an extreme depth of 17 feet, a series of dams of small height, and of locks of small lift. It was the old-fashioned method of slack water navigation. All the dams in the lower portion of the river had to be founded on sand, and so they could not be high. While it might have been possible to maintain a 17 foot channel, it would not have been possible to maintain a 35 foot channel

Furthermore, midway between Lake Nicaragua and the sea, the San Juan River, which is the drainage of Lake Nicaragua, is joined by the San Carlos, a river coming down from the mountains, without having the advantage of the settling basin of a lake, which fills the lower river with sand bars and makes it something like the Platte. Those were the physical difficulties, but it was a very attractive line.

During the next fifteen years, the first change took place. Greytown harbor disappeared, and the last steamer that came to Greytown landed its passengers outside the bar, where they were brought in by small boats and taken up the river.

The difficulty of improving the San Juan River itself has become manifest. Practically, it cannot be done in the lower section of the river where it is full of sand bars ; when the Maritime Canal Company was organized a dozen years ago, and made its plans for work there, it recognized this fact and abandoned the lower end of the San Juan River. The scheme contemplated building a dam across the river which would carry the level of the lake down half way to the sea, extending that lake out between two rows of hills in a lateral valley to within eight miles of the Carribean, and then locking down into that sea Further examinations showed two very serious difficulties in the way of carrying out the plan. The first of those was that no foundations could be found for the dam. The second was that instead of two ranges of hills, with a valley between, there was but one range. There were some isolated hills on the other side, but they had to be connected with a series of very high and very insecure embankment. That was the position, and that was the plan five years ago.

When the Nicaragua Canal Commission was appointed, it was charged only with an examination of the Nicaragua location, and it made more complete surveys, though not by any means as complete as have now been made. The plan was abandoned. They selected another site for the dam and planned a canal nearly fifty miles long from the San Juan to the sea.

The plans of the present Commission are on the same lines, although the details have been very much improved. A better site has been found for the dam ; it is further up stream, and it has a better bottom. The canal between the improved San Juan and the sea continues a portion of the scheme. It is this problem of constructing a canal nearly fifty miles long between the San Juan River and the ocean, not across the summit, but parallel to a river which cannot be made navigable, which has led to the increase in the estimates, and the increase in the apparent difficulties of the Nicaragua line.

If we assume this canal completed, a ship passing through the Nicaragua canal would enter Greytown harbor, which does not now exist, but which will have to be made, and would then travel 46 miles through a canal without interruption until it reaches the San Juan River at the elevation of the lake. In that distance it has to pass through four locks, and the canal itself is 46 miles long. Having entered the San Juan River, it would follow that river which would then be abundantly deep; but it is crooked, so crooked in fact, that some of the sharp bends would be cut off by short pieces of canal; it has to follow that river 50 miles to the lake. It is 100 miles in round figures from the Carribean Sea to Lake Nicaragua. Lake Nicaragua is a beautiful sheet of water. It is surrounded by high hills, and there are two mountains, volcanoes, which rise about a mile, right out of the lake itself. The navigable line would be for 70 miles through the lake, of which perhaps one-third would be in comparatively shallow water, where the channel has to be deepened, and the balance in deep water, which extends it to the west shore of the lake. Leaving the lake, a canal a little over 17 miles long with four locks would take the ship down to the Pacific, where, at present there is no harbor, but where an artificial harbor must be made. The total course of navigation consists, then, of about 65 miles of canal, of 50 miles of navigable river, with enough short pieces of canal to bring the canal length up to about 75 miles, and 70 miles of lake navigation, a total of about 185 miles. This can be passed according to the calculations made by a member of the Commission, by a fairly large ship in about 33 hours. The speed at which a ship would go through the canal would be practically independent of its own power. A fast ship must go just about as slowly as a slow ship. To pass through in that time is perfectly practicable, provided everything is favorable to operating by night. Smaller ships would undoubtedly travel by night; whether the largest ships would, is a question that only experience can settle.

The climate on the west side of the lake is very good for a tropical climate. The climate on the east side is one of the worst in the world. The rainfall at Greytown averages about 240 inches per year. The portion of the line through which the canal proper would be built, the first 50 miles between Greytown and the San Juan, is nearly as rainy as Greytown itself. It is a country practically with one wet season which lasts two years, doubling over the one that preceded it.

As you go up the river, the rainfall decreases until you reach the lake, where there is still a wet climate; when you cross the lake you come to one which is rather dry. The principal difficulty with Nicaragua is just where at first sight you would not expect to find it. It is between the river and the Atlantic. It is through the swamp, whose existence is largely due to the tremendous rainfall.

The principal problems to be met in the construction of the Nicaragua canal are the artificial harbors, which do not present unusual difficulties, but they must be made before much work can be done ; the fifty miles of canal mostly through the swamp, but the upper portion of which involves some extremely heavy excavation, and finally the regulation of the lake. Lake Nicaragua furnishes an indefinite amount of water for a summit level supply. It furnishes almost too much water. It is so great a supply that the water used by the canal is immaterial in proportion to that required for evaporation. The difficulties lie in keeping the lake within reasonable limits, holding it high enough at the end of each wet season to prevent evaporation bringing it too low at the end of the dry season ; this difficulty will be better understood when it is remembered that there have been times, when two dry seasons had a comparatively dry wet season between them, when for 18 months the amount of evaporation exceeded the entire inflow into the canal. This regulation can be done. It has been worked out in a perfectly satisfactory way. The defect about it is that it will require constant and careful watching. The discharge of the river is large. It may possibly run up as high as 200,000 cubic feet a second ; but it would be regulated artificially by a system of sluices, which must be managed, closed and opened at the right times. This is nothing that has not been done successfully elsewhere. But I think that there is no doubt to-day that if we had the same problem before us that we had 50 years ago, and certainly if we had the one that we had a hundred years ago, to supply a waterway by which small vessels could go from ocean to ocean, Nicaragua would be the best route.

At Panama the situation is entirely different. The two oceans are only a little more than 30 miles apart in a straight line There is no intermediate navigation, unless you can call the old canoe navigation of the Chagres River, navigated by boats drawing perhaps a foot, navigation. The advantage of this location is that it is the only place where the oceans approach near together, and the summit is within reasonable height. The summit of Nicaragua, the lowest known, is about 150 feet above tide water. The summit at Panama at the lowest point, is a little less than 300 feet. On the line of the canal it is somewhat more than 300. There are other points on the Isthmus, east of Panama, where the width of the Isthmus is less than at Panama, but a careful examination along the line of the whole backbone shows that no place can be found where the height of the ridge is not more than double what it is at Panama. There is practically no place where the Isthmus can be crossed, except at Nicaragua and Panama without the use of a tunnel; and while some people may not hesitate to send ships through a tunnel, I do.

At Panama the Divide is about 10 miles from the Pacific. The actual length of the canal from shore to shore is a little more than forty miles The actual length from deep water to deep water is about 49 miles. There are two problems which have been the difficult ones at Panama. One is the Culebra cut, the other is the Chagres River.

When the French company began its work there, its people went at it with a magnificent and heroic ignorance. They proposed to cut a sea level canal, and to consider what they would do with other things afterwards. They located their line up the valley of the Chagres for about 30 miles, and then across the Divide in the direction of the Pacific. They afterwards went into various schemes for keeping the Chagres River out of the canal; but nothing was ever done. The Chagres is a tropical mountain stream. It has an ample supply of water for the summit level of any canal, except for about three months in the year. During three months of the dry season its discharge may get as low as 300 feet or thereabouts per second. It looks as if it had dried up. During the greater part of the year, it is a river with a fair supply of water and a good stream. Once in a while, however there comes a tremendous flood. It is possible that the largest floods in the Chagres are as big as the largest floods in the San Juan, but that does not seem probable Those floods are like the floods that we sometimes see in this part of the country in the rivers in the southern part of this State. They are floods which come from violent rains; they do a lot of mischief, and before you know it they are gone. You have seen plenty of those. The problem of the control of the Chagres is to prevent those floods doing any harm. That problem has been perfectly solved by our Commission.

The first thing is to build a dam across the Chagres and convert nearly 20 miles of the river into a lake, that lake to be of such dimensions that no flood will produce a current in it which would do any harm. The surveys and examinations show that this is perfectly feasible; such a lake will form the summit level of the canal at an elevation varying between 85 and 90 feet, or about 13 feet lower than Lake Nicaragua, in which no current would be strong enough to do any harm, and which would ordinarily be a perfectly quiet lake in which navigation would be as easy as in Lake Nicaragua. A location has also been found at some distance from the Chagres where a masonry spill-way can be built, over which the lake will discharge in flood times, and the rate at which it would be discharged can be easily calculated. It is not probable that the flood water over that spill-way would ever be over five feet high, and the water can be taken from that spill-way to the sea without coming into the canal in the whole distance. I have seldom seen a problem more satisfactorily solved than this has been. Furthermore, the lake is to be large enough to supply, acting as a reservoir, the water needed for the summit level during the dry season when the river does not furnish enough. The whole solution, though an artificial one, is absolutely simple, and it will be entirely automatic when done.

When this is completed, a ship entering the Panama canal will navigate the canal for 17 miles at the level of the sea. Then by a flight of two locks, it passes up into this lake, called "Lake Bohio;" it will not pass through the entire length of the lake, but after passing through 13 miles it will turn off towards the south and go through the Culebra cut on the original French location.

This cut is about 8 miles long; it is heavy work for about 7 of those 8 miles; but it is exceptionally heavy only for one. The cut will be about 280 feet deep, and the work remaining to take out of it is about 40,000,000 cubic yards. That has been one of the bugbears of the Panama Canal.

The new French company, since the failure of the old one, has excavated a narrow slice in this cut, for more than two-thirds its depth, and has shown what the material is. It reminded me very much of material that I had taken out myself in North Dakota. It is a very hard clay which costs as much to work perhaps as rock, but which weathers more or less when it is exposed But it is a perfectly stable material, and the troubles which have been reported of sliding soil, etc., are only on the surface well above anything remaining to be done.

Passing through this 8 miles of cut a ship would pass down a double flight of locks to a lower level, go one mile on this lower level, pass through another lock of varying lift according to the tide, and then in about six miles more would reach the line of the shore, and after four miles more in an excavated channel would reach deep water in the old anchorage in Panama Bay. The total length of this canal is about 49 miles from deep water to deep water.

These are brief descriptions of the two canals. The Nicaragua Canal from the ocean to the river, from the Atlantic to the San Juan, is practically as long as the entire Panama Canal from ocean to ocean. The difficulties of construction at Panama have been revealed by the work already done.

The Nicaragua route, however, has one advantage which has been very attractive to many people in this country. The west end of the Nicaragua canal is 500 miles nearer San Francisco than Panama. The trouble lies in the fact that a peninsula extends south about 200 miles on the Isthmus west of Panama; Panama is in about latitude 9°, and a ship going through the canal and up the west coast must make about latitude 7°. This means that when you are through the Nicaragua route you are much nearer to San Francisco and all our northern Pacific ports. This I think is the one advantage which Nicaragua has over Panama as a location for a deep draught canal. But against this there are several things which will weigh pretty heavily. The east end of the Panama Canal is nearer to New York than the east end of the Nicaragua Canal. The time required to pass the Panama canal is about 12 hours. The time required to pass through the Nicaragua canal is estimated at 33 hours. This means that a ship entering the Panama canal in the morning can pass the last lock before dark, and pass out to the Pacific or Atlantic Ocean as the case may be. It means that if a ship is to go through the Nicaragua canal, entering in the morning, she must spend the night in the canal and if she does not wish to run at night she must spend two nights there. If she goes through without stopping, even with a slow ship, one-half the saving in time on the Pacific is lost. If she lies up at night, all that advantage is lost. Beyond that, there is the increased risk of delays. Throwing out the whole of Lake Bahio, the actual length of canal navigation, not including the broadened harbors at Panama, is but little more than 30 miles; at Nicaragua it is in the neighborhood of 70. The risks of delay are hard to estimate; but if a ship grounds in a narrow channel or anything of that kind, all navigation is stopped until that ship is set free. That would increase much more rapidly than the length in which obstructions would occur, because not only would there be obstructions, but each delay would affect more ships. Probably the danger of delays would be four times as much at Nicaragua as at Panama.

There is also a difference in the cost of maintenance, which as far as we have been able to determine, is somewhat more than a million and a quarter dollars a year.

There is another advantage in favor of Panama, which I attach more value to, perhaps, than other people do. It would be a short strait from ocean to ocean, without any unnecessary complications with countries which it runs through. There would practically be no country; one end is almost within sight of the other; whereas, a line nearly 200 miles through the center of a country which would be more or less inhabited for the whole distance, might involve local international complications which it would be well to avoid.

There is also the question of protection. The canal would have to be protected, not defended against first class powers or fortified against strong nations, but it must be defended against the weak people who are around it. The trouble will be more in the nature of police than fortifications. At Panama a force can be brought from any point on the line of the canal to any other in less than two hours; probably if the railroad is maintained in high condition in one hour. At Nicaragua unless a railroad is built for the whole distance around the Lake, which has not been contemplated, it will take at least 12 hours; it will require a very much larger force, involving very much greater difficulties in policing.

These are some of the reasons why the Panama canal is to be preferred. They are not all. The question of cost is a very important one. The amount required to finish the Panama canal, according to the estimates of the Commission, and I think those estimates are ample, is about 140 million dollars. Of that a considerable amount can be deferred until after the opening of the canal. This estimate includes duplicate locks throughout, and it includes the deepening of the harbor channels at each end; this must be done sooner or later, but the present channels will accommodate a very large traffic so that I feel that there is no doubt that the canal can be opened to traffic with a present expenditure of somewhere from 110 to 120 million dollars. It would not be finished but it would be serviceable.

The Nicaragua canal has been estimated on precisely the same basis, the same prices for everything, the same percentage for contingencies, the same allowances, it being determined to put the canals as nearly on equal bases as possible. And yet, in a country uninhabited, as the country between Greytown and the San Juan River is, where all laboring population must be brought in, where every bit of country must be cleared, where no roads are possible because it is such a swamp, the risk of actual cost overrunning the estimates is considerably more than in the open country at Panama.

The work done at Panama by the old French company was of a reckless magnificence which has probably never been equaled anywhere. That company actually raised something like $240,000,000 in cash. Perhaps two-thirds of this went to the Isthmus. Perhaps one-half of that two-thirds was actually expended in excavation and work. A great deal of it went into machinery; some of that machinery is in good order, some of it is not. But those of you who have had to do with machinery know how much a machine is worth which is 20 years old. That is specially true of excavating machinery and everything of that kind. You had better throw it away. You could not afford to take it as a gift if you had to use it.

The value, however, which the French management attached to what they had done and to their machinery, their manner of estimating it and their method of avoiding negotiations, were such that the Commission felt that the only thing it could do was to tell them to go home. It was a case where it was not merely a question of what we could afford to give for the work, but whether the United States Government could afford to be imposed upon by foreigners? The Commission decided that it could not. Now, this has been entirely changed. Not only has the management of the French company been entirely changed, but it has submitted an offer to accept for the entire plant the amount which the Commission has estimated that it is worth; and that amount, if paid for the Panama Canal, will be an absolute fixed payment with no chance for uncertainty or contingencies, with no possibility of a wrong percentage for uncertain errors. And it has accompanied that offer with legal documents showing that it can pass an absolute clean title to our Government.

That, however, would not enable our Government to build the canal. We could not work under any such concession as the French worked under. It would simply clear the ground so that we could make such treaty as we saw fit.

I do not know that I need say anything more on the merits of the two lines. The only advantage that I can see in Nicaragua, and I think that any engineer who has carefully investigated it will see, is the fact that the west end is nearer to San Francisco than the west end of the Panama Canal, and this is largely neutralized by the additional time required to pass through the canal, and entirely neutralized if you consider the additional risk.

There are some things about distances which I would like to call your attention to. They are easy to remember, and they are very suggestive. We all measure our longitude from Greenwich; Greenwich is practically London. The Mississippi River, as marked by St. Louis, Memphis and New Orleans, all of which are on the same meridian, is in longitude 90° west. The mouth of the Ganges is in longitude 90° east. The mouth of the Mississippi is directly opposite the mouth of the Ganges. The mouth of the Mississippi is almost north of where the Isthmian Canal would be. The mouth of the Ganges is a long way east of the Suez Canal. This means that very little business can be expected to go from any European ports through the canal across the American Isthmus. This canal must stand on its own merits. It must be a canal for American traffic. Furthermore, our Atlantic ports can reach Chinese ports by a little shorter route through the Suez canal than across the American Isthmus. Manila is about equally distant by both routes. Japan would be nearer by the American Isthmus,

Another thing: A great circle curve drawn from the terminus of either canal to San Francisco would be almost entirely on land, it would pass through New Mexico; the shortest route by which any vessel could go from the terminus of either canal to Japan would take them so near to San Francisco that San Francisco would naturally be a coaling port. The distance from Panama to Yokahoma, by way of San Francisco, is less than by way of Honolulu. San Francisco, furthermore, is the one port on the west coast of America which is nearest, not only to China and north Asiatic ports, but to Australia and New Zealand. There are some curiosities of this kind which it is important to think about.

From New York to San Francisco is 5144 miles by way of the Panama Canal. A 15-knot ship going 360 miles a day would make that trip in about 15 days, including the canal, if everything was all right; from Plymouth, which may be taken as a sample European port, the distance is 7674 miles. That would take 21 days including the canal, probably with coaling, etc., 23. The opening of the canal would place our Pacific coast in direct communication with our Eastern coast and with Europe. It would place our Eastern coast and the Mississippi Valley in direct communication with the West coast of South America, the trade of which is now held in European hands. This is a thing to which little attention has been given, but it is likely to prove a very important one. But after all I know of nothing which you can rely on less, than statistics of transportation on a transportation route which does not exist. The profits and the business of the canal must be the results of conditions which that canal will create. The French company made very nice calculations based on the position of ships all over the world for several years. But the real fact is that the opening of this canal will encourage certain interests on our West coast and elsewhere, which cannot fail. in my judgment, to change many lines of trade, and to create traffic which does not now exist. If it were only to be the traffic which does exist, I should agree with Mr. Ripley and doubt the expediency of building the canal.

There are two other things which should be referred to. We have a much larger merchant marine than is commonly supposed. Our navigation laws prevent our knowing what it is. No ship can sail under the American flag unless it is built in America; and the result is that other nations are getting the credit of shipping which we own. The International Navigation Company, for instance, owns four ships which sail under the American flag between New York and Southhampton. They own two or three auxiliary corporations, formed under English and Belgian laws, which own several times as many ships which are sailed under foreign flags. The heaviest freight carrying line now sailing out of New York is owned in this country, the Atlantic Transport Line, and yet it has not a single American ship. Possibly our navigation laws will compel a continuance of this abnormal condition. But whether they do or not, we are no longer out of the carrying trade. We are performing it secretly under other flags, and our ships will get quite as much benefit out of that as anybody, and we soon shall have as many as any nation.

Our coasting ships under our present laws can attend to our east coast and to our west coast. They cannot communicate between the two. With a canal they can. We could not take fleets through a canal in all probability in times of war. But the value of a fleet is not so much to fight in war, as to prevent the occasion of war; and the exercise and duties which an American fleet could perform with the existence of a canal, the change of stations and the discipline of squadrons would be very greatly improved. Our fleets would be much more effective, not perhaps in fighting, but in preventing the necessity of fighting.

The Isthmian Canal

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AN ADDRESS

BY

MR. GEORGE S. MORISON

OF NEW YORK

Member Isthmian Canal Commission

DELIVERED APRIL TWENTY-FOURTH, 1902
BEFORE THE MASSACHUSETTS REFORM CLUB

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The ISTHMIAN CANAL

AN ADDRESS

By MR. GEORGE S. MORISON

Before the Massachusetts Reform Club
April 24, 1902

Mr. President and Gentlemen of the Reform Club:

I had supposed that the Isthmian Canal question was one of such importance and such interest that all members of this club knew something about it. After the confession of your president, I can say but one thing: I hope his ignorance is not characteristic of the other members of the club. If it is characteristic of them, which I am not willing to believe, I must simply say that I am the wrong man to-night; for I have not come to speak of the relative merits of the different canals. I have thought that was a subject which had been described and talked of until it was understood. Two months ago, in another city where I was asked to speak on the matter of the Isthmian canals, I did describe their relative merits and gave my own views as succinctly as I could. I do not wish to repeat to-night what I said then; but if your president will promise to give up his prejudiced ignorance and to read what I said that night, I shall be happy to give him a copy of it and let him lend it to any other member of the club who may prove to be as ignorant as he is himself.

I have considered that the question of physical superiority had been thoroughly and permanently settled in favor of Panama. I remember saying to some of my friends more than 20 years ago, when I knew little about the subject and when the matter of the Isthmian Canal was first brought prominently before the American public as an actual work to be done, that I believed the true solution was a tide-water canal at Panama; but that I believed it was so expensive and so difficult a thing that its construction should be deferred till the twenty-first century, and that the Nicaragua Canal would make a cheap tool to be used meanwhile. I confess that even then my views were wrong. But the changes which have taken place on the ocean, in the merchant marine, have been so rapid in those 20 years that even assuming that Nicaragua would have made an economical and efficient tool 20 years ago, it would not do so to-day.

A general comparison of the two canals may be very simply made. The first great advantage of the Panama Canal is that it is so short a line between the two oceans. This means that a ship can enter it in the morning and be in the other ocean at night. To go through the Nicaragua Canal would require three times as long as to go through the Panama Canal. That means one of two things: It means either running three days, thus losing two more than at Panama; or it means running by night. That small ships would go through the canal and river by night, I have no doubt. But that large ships would do it in a country of Nicaragua's climate, where there is one of the heaviest rainfalls in the world, I do not believe. This is, in the first place, the prime great advantage of the Panama Canal, the short time which a ship will have to stay land-locked. A ship belongs at sea; it does not belong 25 miles inland.

The next advantage, which comes from the same short length of the canal, is the fact that the Panama Canal, crossing the narrowest portion of the isthmus, will occupy the position of a strait; it will not interfere in any way with the countries on either side. It simply is the occupation of a line of transit, which can be kept entirely clear of international complications. The Suez Canal has become the recognized boundary between Asia and Africa. There is no reason why the Panama Canal should not become the recognized boundary between North and South America. This cannot be done with the Nicaragua Canal. The Nicaragua Canal must go for practically 200 miles through a country which is capable of settlement and development. This long stretch of country cannot be occupied without more influence on the adjoining countries than it is desirable to have. One is an independent location. The other is a location complicated with surrounding political conditions.

These two reasons alone seem to me absolutely conclusive as to the superiority of the Panama Canal when it is done. There is one other thing upon which I ought to say a word, principally because of the ignorance which your president has expressed and has tried to ascribe to the whole Reform Club. The best possible solution would be the tide-water canal, when it was done. Of that, I have not the slightest doubt. But the difficulty in building a tide-water canal is principally one of time. It would probably take at least 20 years to construct a tide-water canal at Panama. It might take 25 or 30. This is a very serious thing; and the advantages which the tide-water canal would have over a canal with a moderately high summit level, approached by locks, are not commensurate with this additional loss of time.

So much for the canal when it is done. There is another thing to which I attach considerable weight. I fully believe that the Panama Canal, including all that may be paid for concessions of French rights or anything of that kind, will cost a great deal less than the Nicaragua Canal; that the difference will be very much greater than has been estimated even in the report of the Isthmian Commission. There are several reasons for this. The Commission, in its effort to put everything on as even a basis as possible, has perhaps overstepped the mark. The same prices have been used throughout for both canals. The same percentage has been added for contingencies, although at Panama a very large portion of those contingencies have already been met and provided for in the work which has been done, and although the opportunities for investigation and understanding are very much greater at Panama than at Nicaragua. Furthermore, in the estimates made for the work at Panama, provision has been allowed for a great many things which would not have been allowed for, if we had had only the uncertain information given by borings and the like. In one instance it amounts to many millions; rock prices have been used at the Culebra cut with earth slopes; and an exceedingly expensive retaining-wall has been provided, which would have been almost entirely omitted if we had had no further information than what existed before any work was done.

There is another element. It has been considered by many that the limit of time required to complete a great work was the time required for the largest single item of that work. This is perfectly true in a country supplied with labor, with facilities of transportation and other such things as exist in the United States or any of the other settled portion of the world. But it is not the case on the isthmus, where there is practically no working population, where there are no lines of access, where everything must be brought in and everything must be got ready. While some of my colleagues have differed from me, I have not the slightest doubt that in actual practice it will take at least one-quarter longer to build the Nicaragua Canal than to finish the Panama. I might cite, as an instance of this, the construction of our Pacific railroads 30 years ago. Their time could not be determined by the time any great work on the line required. They had to be begun at the two ends and built till they met in the middle. It was slow work at first, gradually hastened. Those roads were built in what was then considered marvellously quick time. They could be built in one-quarter of that time now, simply because we have access to them.

Nicaragua has been supposed to have three special advantages. The first of these is the position of its western terminus. The western terminus of the Nicaragua Canal is more than 500 miles nearer San Francisco than Panama is. That is an undoubted fact and an undoubted advantage that Nicaragua possesses.

The next supposed advantage is in respect to sanitary conditions. Nicaragua has been supposed to be very much more healthy than the Isthmus of Panama, and this is true. But the statistics of mortality are always meagre in a population that consists principally of monkeys, and that is the principal element of the population of the swamps of Nicaragua. Epidemic diseases seldom exist in countries without human population. This is the state of affairs at Nicaragua. The eastern end of the Nicaragua Canal, for a length about equal to the whole Panama Canal, runs through a country with an average rainfall varying from 240 to 300 inches a year. It is something like double the rainfall on the Isthmus of Panama. The friends of Nicaragua have explained the superior healthfulness of this district on the simple principle that it is perfectly healthy to be dry, it is perfectly healthy to be wet; it is very dangerous to pass from wet to dry, and in this region you never have to do it. Perhaps this is true. I will not deny it. But the fact remains that the rainfall is such that that region is a continuous swamp, and that the conditions will be very greatly changed when the swamp is opened and work is carried on. The Isthmus of Panama undoubtedly is a very unhealthy place. It has been inhabited by one of the worst populations of the globe. Its sanitary principles have been conducted in the same manner as in all Spanish-America, where the concealment of filth from the eye, without reference to the other organs, was all that was ever asked for. The experience of the last few years in Cuba is one of the most valuable things which have ever occurred. Cuba, in itself, is probably one of the healthiest islands in the whole world; but it has been made a hotbed of disease simply by the principles which have governed sanitation in Spanish America. The existence of filth in all kinds of places, accompanied by the excursions of the striped-legged mosquito, seems to have been the cause of all the illness in the Island of Cuba. It has undoubtedly been the cause of much of the illness on the Isthmus of Panama. What the actual facts would be if work were undertaken on the two isthmuses, no one can say; but for my own part I feel that it is a case of infection at Panama and a case of malaria at Nicaragua. There is malaria at both places. But I would rather, myself, attempt to wipe out the bad infectious troubles on the Isthmus of Panama than to eliminate the dangers of the swamps at Nicaragua.

The third advantage of Nicaragua has been supposed to be that there a clear title could be obtained without any complications with the vested rights of other parties, and for a time this appeared to be true. The complications at Panama seemed to be of such an aggravated character that there was danger that they would preclude the construction of the canal on what was preeminently its best location. Furthermore, these complications extended, not only to the site of the Panama Canal, but to every possible canal site within the Republic of Colombia. That has been changed. The rights under which the French company has been building this canal are totally inadmissible for the construction of a canal by the United States Government. But they were a cloud on the title; and the offer of the representatives of that company, accompanied by an agreement with the representative of the old, defunct, original company, to join in a conveyance in the nature of an absolute quit-claim of every right and title of any kind on the isthmus, puts the Panama position legally in a much clearer light than the Nicaragua position. It is an absolute quit-claim from every one who has any rights there. At Nicaragua all that our country is offered is the assurance of the Nicaraguan Government that it has forfeited rights which had been granted and had not been used. The title is clearer at Panama than at Nicaragua.

This is simply a general account of the relative positions of the two to-day. The one advantage that Nicaragua has, is that its west end is 500 miles nearer San Francisco than Panama is. And this means much less than it sounds like. If a steamer goes through Nicaragua night and day as fast as it can go, it may be able to get to San Francisco in one less day than it could if it passed through the Panama Canal. But if it runs only by day and lies up at night, the time is equal for the two. And this is the case with freight steamers of moderate speed. A high powered passenger ship, even if it ran night and day, would lose as much time in going through Nicaragua as it would take to make the additional 500 miles if it went through the Panama Canal. Perhaps you may say that fast passenger steamers will not go through there, and that is perfectly true. But the speed of the freight steamer to-day exceeds the speed of the passenger steamer of 30 years ago. Whether such changes will continue, I do not know. You can judge as well as I can. But I mention it merely to indicate the possibilities. I shall say nothing further of the relative merits of the canals; but in all that I say after this, I shall assume that Panama is the canal which is selected and is the one which will be built.

Going now to a different subject, what are the reasons why a canal should be built? And first, what are the commercial reasons for building a canal? Being a Reform Club, I presume commercial reasons are of secondary consideration to you; but they ought to be considered.

There are several classes of traffic on which the opening of the canal will have very important influences. First of all, there is the trade of the west coast of North America. The construction of this canal will put San Francisco, which may be accepted as the commercial center of the Pacific Coast, and not only that, but the port which almost all business going to any point north of Mexico, whether in America or Asia, will seek—the construction of this canal will put San Francisco within 15 days of New York by a steamer of the same class as the Morgan Line of steamers running between New

York and New Orleans; and within 23 days of any English port, by the same class of steamers. I think that tells its story. What it means is that it extends our coasting trade to the whole of our country. It extends it there on practically the same lines that it is now conducted between New York and Boston, between Boston and Baltimore, between New York and Charleston and Savannah, between New York and New Orleans, or between New York and Galveston. That trade would to a certain degree be taken from the present transcontinental railroads. They would lose a business which they do now. But the railroads terminating at our South Atlantic and Gulf of Mexico ports do not seem to suffer from the coasting lines of steamers. In fact, the development which these steamers have rendered possible has been of the utmost benefit to the railroads. It will be the same way if our coasting trade is extended through the Panama Canal to the Pacific Coast. The impetus it will give to the various developments of the California, Oregon and Washington coast will much more than make up for any particular traffic that may be lost. Furthermore, it will have one other effect. Our whole coasting fleet will be available for our entire coast. At present there is one fleet on the Pacific, another fleet on the Atlantic. They cannot go from one to the other. At times it leads to very unsatisfactory conditions, especially on the Pacific Coast.

The next class of traffic which must be considered is that of the eastern coast of the United States; and this both in its connection with the west coast of North America and with the west coast of South America and with Asia. And there comes in a curious thing which those people who have studied geography by maps know little about. If you want to go from Panama to Yokohama and to make a coaling port on the way, there is no other port which is a quarter as convenient as San Francisco. The route from Panama to Yokohama by way of Honolulu is several hundred miles longer than the route by way of San Francisco. Practically all the Asiatic business that goes through the Panama Canal will go to San Francisco. San Francisco will be the coaling port. San Francisco will be the port where mails and passengers will be received. San Francisco will get the benefit of nearly everything belonging to that business, in spite of the freight which goes through by water. So far as business beyond Yokohama and Hong Kong is concerned, the situation is different from what might be supposed. The mouth of the Mississippi River is in longitude 90 deg. west. The mouth of the Ganges is in longitude 90 deg. east. The mouth of the Ganges is directly opposite the mouth of the Mississippi; and the Mississipppi is as far west of London as the Ganges is east. There is no European traffic for the far East, unless for a portion of New Zealand, which will not find a shorter route through the Suez Canal than through the Panama. Starting from New York, Manila is practically a common point. Manila may be reached about as easily by way of Suez as by way of Panama. The Asiatic business which would seek the Panama Canal is the business of the United States with Japan and China. The business of the United States with India and with everything west of the Straits, would find other better routes. That is practically the limit of Oriental business which would seek this canal. And that business would take the northern route and stop at San Francisco.

There are, however, two other classes of business which would go through that canal. The first is the business with the west coast of South America, a business which seems to have great possibilities of development, but in which the United States has hitherto had exceedingly small interests. That west coast is now served by several European lines of steamers, which, passing through the Straits of Magellan, come up on the west coast; while some of them make connections at the isthmus, and transfer. But the opening of this canal will place the west coast of South America 3,000 miles nearer our ports than to those of Europe. It will give us the opportunity to do there what we are doing in Mexico and in the West Indies. It will give us an entirely new field for commerce, and one which may be of the very utmost importance. These classes of traffic are the ones which the canal will open. The canal will also form our best line to New Zealand and Australia. How much business we shall have with those regions I do not know. Many people are familiar with those special traffics. But, at any rate, the principal thing to be observed is that the business which will go through the canal when it is done, must be very largely a business which does not now exist. When our western wheat can be taken to Liverpool in 25 days, instead of 140, we may expect certain results from it, when you consider the less amount of capital which will be tied up, which are otherwise impossible. I cannot help feeling that the traffic through this canal will actually be enormous; and that the present statistics of traffic now existing are no indication of what it will be. Furthermore, it must be a traffic of coarse tonnage, carried at low rates, and which will bear comparatively low tolls. It will not be the same class of traffic that goes through Suez. And it will be a traffic which is likely to require the same changes of rates which have occurred on American railroads. It is a parallel case. No American railroad that I know of could have operated profitably on the business that existed before it was built. And the most profitable railroads have been those which had the least traffic before their construction, whose traffic was only possible because they existed, and whose traffic has continued to increase in profit because the continual decrease of rates has led to a much more rapid increase of volume. That is what I look for in the case of the canal. There are no estimates which are entitled to less consideration than estimates of traffic, made before that traffic comes into existence. And I know of nothing which has fulfilled its expectations in a measure more incommensurate with what they actually were, than the traffics which have been developed under similar conditions.

Another reason why this canal should be built is a political reason, and to this political reason, a great deal of value must be attached. As this is a Reform Club, and not a commercial club, I presume it is busied with political rather than with commercial considerations, and that such considerations here will be given their full weight. And, in the first place, I would say that in all political matters the human element of the problem is very large. Erroneous as commercial calculations are likely to be when made purely as calculations, the error in political calculations made on the same basis is probably much greater. However much may be said about the cost of a canal for political reasons, the voyage of the "Oregon" was an object lesson which has weighed much more with nine people out of ten than any such calculations possibly can. We may figure that the interest on the cost of the canal would build three ships and put them on the Pacific every year, and that in that way we could have a double navy instead of a single one. But, whether that be true or not, it does not meet the condition, and it certainly does not satisfy the public mind. Our government is the first government of the kind the world has ever seen. It has been trying to do something which has never been attempted before. It is conducting the general legislation for the country in all matters to which the general government attends, on the principle of a legislature elected by popular votes in States which are widely separated geographically. We call for and desire, our whole government is based on the principle of, the unity of this government. The danger is, that such unity of government cannot be maintained without a unity of interest. It is of the utmost importance that every step should be taken which we reasonably can take which will further a unity of interest, which will make the interests of the Pacific States identical with those of the Atlantic; the interests of the Southern States identical with those of the Northern. I know of no one thing which will do this as much as the construction of the Isthmian Canal. I feel that this alone is perhaps the strongest reason of all for building the canal, and alone it is a sufficient reason for deciding to do it.

This is not all. The position of our country is one which we know. It has become a great country among other nations. It has become a country of great production and great capacity. It has become a country with rapid lines of transportation and a great many other things of the kind. I feel that this work has been accomplished very largely through my own profession; that the civil engineer, the man who directs the great sources of power in nature for the use and convenience of man, has made the American Republic, as it is to-day, possible. He has not only made it possible, he has made it inevitable. He has brought about a condition which a hundred years ago many of our statesmen were afraid of. But he has brought it about in a way in which it could not possibly be avoided. We can no more step back of that condition than we can live again in the sixteenth century. It is an absolute fact which must be accepted and which we must work under. It has primarily been rendered possible by the engineer; but it is a work in which the merchant, the traveler and a great many other people have had their part, a work which is being done and which will continue to be done. This club, as I believe has been said before, is a Reform Club. The reformers have been the radicals of the world, they have not been the conservatives. I suppose I may therefore assume that the object of this club is to be in advance of the ideas of the people and to set a pace perhaps a little too fast, but never too slow. The conditions under which the country now lives must be accepted, they cannot be reversed. Our acts must be such as will make the very best terms out of what exists, and bring about the very best possible results. And, from this point of view, we require the canal. We require it for our foreign trade development. We must have a market for our goods. We must be able to reach that market. The construction of the canal will practically put us as near as any European nation is to all the world excepting Europe and the western part of Asia. That is one reason why we need it.

And then we need it for another reason. We need it, not merely to make a market for our goods, but to develop the kind of trade we need and to develop it in the way in which our country will prosper most. I know of no single agency which will bring about the graduation from our economic education more quickly than the Isthmian Canal. And by economic education, I refer to tariffs and matters of that kind. I have always believed in protection. I have been a protectionist and am to some extent now, but I look upon protection in the same way that I look upon education. It is justifiable because it leads to something else. A college training is valuable for the after life, but the boy who after going to college devotes his whole life to the acquiring of an education which he does not use, makes a very poor citizen. When protection has established a business which no longer requires it, it should be withdrawn. A business which can never be expected to live without protection should never be protected. We are now the leading iron manufacturers of the world; protection has hastened this result by many years and has done a good work, and that work is now completed. There are some things which we can make better or cheaper than countries in any other part of the world, and it is our interest to find a market for these goods. There are other things which we can never make as well as or as cheaply as some other nations can, and it is for our interest to be a market for these goods. A market for the articles in which we usually excel will be found in countries west of the Pacific and on the west coast of South America. All those countries are eminently capable of producing articles which it is not natural for us to make; if we cannot get this foreign trade we need a protected home market for our manufacturers; if we can get this trade where we can sell that which we can make best we shall be in a position to buy to best advantage that which we can produce only under difficulties. This means breaking down the policy of isolation. We have already started in this way and we are talking about reciprocity. From this point of view I know nothing which will bring about such a result sooner than the construction of an Isthmian canal will. It will put us in communication with all portions of the world where we can sell as well as buy. Armed with the diploma of a protective education we shall be ready for free trade.

That is all I have to say about the character of the canal and the reasons why it should be built. There is one other aspect on which I wish to touch. And that is, how should it be done? And in this matter I think the experience of the Spanish War and since then has been of the utmost value to us. I believed in the Spanish War. I was always in favor of it. There are many reasons which I see now why it has been good for us, and this is one; it has taught us how to occupy a tropical country, how to handle that country and how to get good results. We took the Island of Cuba, a pest-hole of yellow fever. After three years, the amount of sickness among American soldiers in Cuba is much less than it is in the United States. The Panama Railroad was built when sanitary principles were not known and when little care was taken; and there was an enormous loss of life and a terrible name given to the isthmus. The French Company began constructing the canal, and imported into the isthmus many of the luxuries and vices of their northern capital, and the death rate was renewed. The city of Panama is a pest-hole; but it has never been as bad as Santiago de Cuba formerly was; and there is no reason why Panama should not be as healthy as Santiago de Cuba is now. The first condition is, that there must be an absolute military occupation of the isthmus, with the same control for police sanitation and everything else, that we have had in Cuba. Panama is not naturally a healthy country, as Cuba is. But it is not any worse than nor so bad as the St. Francis bottom nor the Sunflower country, with which we are all familiar and which are in the heart of our own country. That military occupation must extend to everything which influences health, to police and other regulations; and it must be continued during the whole construction of the canal. I do not believe there are any men in the world as capable of making that military occupation efficient and good in its results as the men who have been trained in our own army in the Cuban occupation.

Then the work must not be started too soon. Two years at least should be consumed in preparation. Get ready thoroughly before you begin. I fully believe that with two years spent in preparation, the canal would be open three years earlier than if only one was spent. Those two years of preparation would be required for the detail surveys, the complete plans, the complete specifications, the complete organization for carrying on the work, and especially for the general cleaning up required for sanitation. The filth of 400 years must be taken from under the houses and dumped somewhere in the Pacific or the Atlantic. The isthmus, which has been occupied for 400 years, practically has not a water pipe on it. There is plenty of good water on the isthmus, excellent water, but it must be brought to the towns and to every place there; and people must be compelled to use it instead of drinking from the swamps. This kind of work must be done throughout and everything should be in shape before the actual laboring force is brought there, before the work is begun. Panama is an old city, built at the head of a bay with an enormous tide. We may be confronted there with some of the same sewage problems that were handled in Boston, only it is a city of 20,000 people instead of half a million, and the tide is so great that the discharge from the sewers can be conducted without any pumping, by simply letting it out on the turn of the tide. There is no reason why it should not be done at comparatively small cost, especially as there is no expense to get below frost. Colou is a smaller place, but naturally a worse place. It is practically built on a swamp. It is a miserable town. Perhaps it had better be burned up, and another town built at a higher level after grading it up. That is a detail to be determined hereafter. If that course were adopted, the buildings are not sufficiently valuable to make the expense of the conflagration unreasonable. There is a moderate amount of swamp in the first ten miles south of Colon. There is some swamp back of Panama. These swamps will undoubtedly have their evil influences. There will be some malaria. You can get rid of yellow fever. And perhaps by that time we